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Soil landscapes of Canada

PROCEDURES MANUAL AND USER'S HANDBOOK

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Preface

Map compilations, involving many people and soil survey agencies, require certain rules and standards to ensure consistency between them. Such is the case of the generalized soil landscape maps compiled by the Land Resource Research Centre (LRRC) of Agriculture Canada. Moreover, if, as is planned, the maps or related attribute data will be updated periodically, the need for consistency and documentation will be even greater. This manual describes the procedures by which land features across Canada are represented on generalized maps and legends; it also defines the attributes that are used.

In 1982 the Generalized Soil Landscape Working Group was established within the Expert Committee on Soil Survey to select differentiating attributes, construct a Phase 1 map legend, and develop the generalization mapping methodology applicable to small-scale mapping. The Prairie Provinces were selected as the pilot study area, and maps of Manitoba, Alberta, and southern Saskatchewan at a scale of 1:1 million were completed by 1984. During the same period, exploratory mapping at 1:1 million scale was also conducted in the Northwest Territories. Three years later, in response to a request by the Eastern Canada Soil Degradation Project, generalized mapping was extended to cover that agricultural region; more recently, coverage was extended westward to include British Columbia and Yukon Territory.

The entire project entailed a number of tasks and objectives including:

- compiling small-scale maps (1:1 million scale) to depict contrasting soil landscape areas
- developing a standardized national legend for all soil landscapes
- describing either one, or at the most two, distinct soil landscapes in each area depicted on the map
- describing them in terms of attributes that are relevant to biological productivity, soil degradation risk, and terrain sensitivity
- designing the necessary procedures, forms, and manuals (of which this is one) needed for the project.

At first the agricultural area of Canada was mapped (Phase 1) and a short set of attributes was compiled in an extended legend. Afterwards, the nonagricultural portion of the following areas was filled in (Phase 2): Prairie Provinces, Island of Newfoundland, British Columbia, Yukon Territory, southern Labrador, and the southwestern part of Quebec. Only northern Ontario, parts of Quebec and Labrador, and the Northwest Territories remain to be compiled.

This manual represents the sixth revision of procedures used during the soil landscapes of Canada project. It documents the most up-to-date extended legend according to Phase 2 standards for mapping and compilation of attributes. It supplements map compilation procedures, attribute descriptors, and the detailed computerized legend referred to in the report that accompanies each soil landscape map.

Acknowledgments

The dedicated efforts of many persons who willingly contributed to the compilation of this manual are sincerely appreciated including:

- Staff of the LRRC Inventory Section and associated provincial soil survey agencies for their contributions to the project development, for compilation of maps and legend attributes, for inputting, reviewing, and editing the computerized data base.
- Staff of the LRRC Information Systems Unit for the preparation of base maps and for the production of maps and figures.
- Linda Howe and Sandy Roy for their expertise in word processing and their patient cooperation in formatting and typing this manual.

Introduction

Planning suitable uses for land requires a wide perspective. To assess the potential for cereal production in the prairies, corn production in eastern Canada, or wood production for the whole country, we need consistent and comparable information about the soil and land nationwide. This information is difficult to assemble into an easily manageable product from the large-scale maps and surveys generally available.

Consequently, the Inventory Section of the Land Resource Research Centre (LRRC) undertook to compile a computerized data base to record the attributes of the soil and land for the whole country and to prepare maps from this information at a scale of 1:1 million. The compilation is done by standard methods. The maps are divided into unit areas called polygons. Each polygon is described in terms of a standard set of attributes. These attributes are the factors considered most important for plant growth, general land management, regional planning, terrain sensitivity, and environmental sustainability. The full array of attributes that describe a distinct type of soil and its associated characteristics, such as landform, slope, water table, permafrost, and lakes, is called a soil landscape. A polygon may contain one or two distinctive soil landscapes, as well as small but contrasting inclusions.

The maps themselves and the attributes of every polygon shown on them are stored in the computerized Canada Soil Information System (CanSIS). The information can, therefore, ultimately be made available as paper maps and short reports, and in electronic form.

Objective This manual is to document the standard methods and descriptors used by all provinces for compilation of a national soil landscape data base at a scale of 1:1 million, including:

- map compilation from existing source maps or LANDSAT data
- a map legend describing permanent soil and landscape attributes, which can accommodate all major soil mapping systems used across Canada
- a computerized extended legend with defined file structure, attribute list, and class descriptors
- maps in digital form
- products available.

Product usage The products can be used for the following purposes:

- to assess the productivity of the land nationally or over large regions
- to find areas that have actual or potential problems affecting land use, such as salinity or susceptibility to erosion, and to assess the severity
- to locate general areas that may be suitable for particular types of land use, which can be selected for more detailed investigations
- to apply general research findings and agrotechnology procedures that are successful in one part of the country to other areas that have similar attributes

- to link soil and land information with other data bases, such as information on climate, economics, or census, for assessing land use on a regional, national, or even an international scale
- to educate students of soil geography at colleges or universities.

How to use this manual

This manual is designed especially to supplement map compilation procedures, attribute descriptors, and detailed computerized legend data included in the report accompanying each soil landscape map. It documents "General legend concepts and definitions" used in this small-scale mapping project followed by "Map legend development" and "Map compilation" procedures. Users requiring information concerning the map, the map legend, or the accompanying report are referred to the above sections.

Users wishing to use the more detailed computerized extended legend that describes the dominant or subdominant soil landscapes of each map polygon are referred to those three sections. One section provides the attribute list and structure of the computer files for the dominant and subdominant soil landscapes; two other sections provide a detailed description of the attributes and their different classes. As users become more familiar with the data base, they will find it more convenient to refer to the section summarizing soil attribute codes and their classes. The content and definition of digital data for soil landscape maps are described in another section.

Products available from this project are summarized in the last section. These products (Fig. 1) include a map and a printed report containing a tabular extended legend of the 12 major soil landscape attributes occurring in each map polygon. A more detailed computerized legend providing 40 attributes for each polygon is available electronically on diskette in ASCII format.

General legend concepts and definitions

The framework for the legend development, map compilation, and attribute characterization is established by the following concepts and definitions:

- The maps are comprised of map delineations called polygons, each of which is described in terms of a standard set of attributes.
- The full array of polygon attributes that describe a distinct type of soil and its associated landscape attributes, such as surface form, slope, water table, permafrost, and lakes, is called a soil landscape.
- A polygon may contain one or two distinctive soil landscapes (dominant or subdominant) and may also contain a small but contrasting proportion of inclusions.

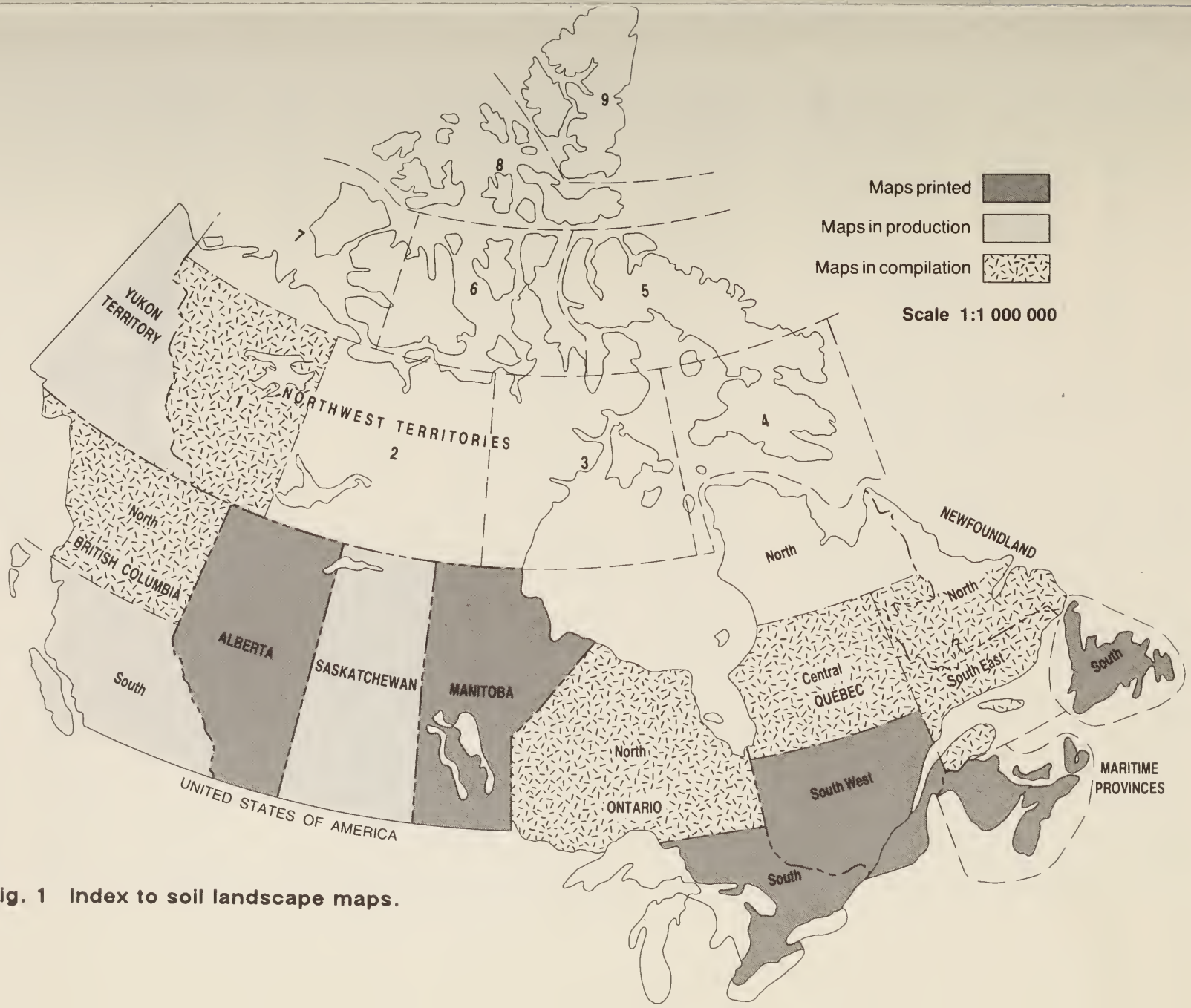


Fig. 1 Index to soil landscape maps.

- The dominant (or most prominent) soil landscape represents at least 40% of the polygon area whereas the subdominant soil landscape represents only from 16 to <40% of the polygon; inclusions represent a maximum of 15% of the polygon; a more detailed description of complex map polygons is given in a later section.
- One or two inclusions can be recorded for each dominant and subdominant soil landscape, but in total they represent only a maximum of 15% of the polygon land area.
- Each polygon is assigned a unique identifying number.
- The attributes that separate one polygon from another include (a) soil development, (b) soil parent material mode of deposition, (c) texture class of parent material, (d) local surface form, (e) slope gradient class in percent, (f) kind of rock or surface material except water, and (g) spatial occurrence of these attributes within a polygon; these attributes may apply to either the dominant or subdominant soil landscape.
- The minimum size of the soil landscape area (or polygon) should be about 1 × 1 cm at the 1:1 million scale (100 km^2); however, smaller, isolated areas that can be conveniently displayed and labeled on the map are permitted when needed (see "Map compilation").

Map legend development

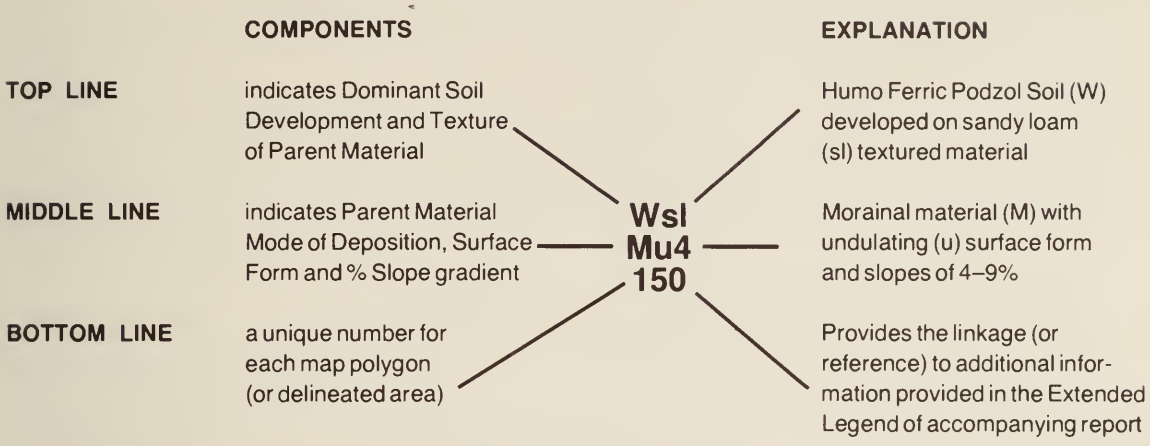
A standardized map legend was developed (Shields 1982) consisting of major attributes important to plant growth and land management, which are used to differentiate one map area (or map polygon) from another, plus additional attributes that are required to make priority interpretations. The sum of these attributes are stored in the computer files of CanSIS as described later.

Major attributes The attributes shown in the map symbols (Fig. 2) and legend serve to differentiate one polygon from another. They were chosen for the following reasons:

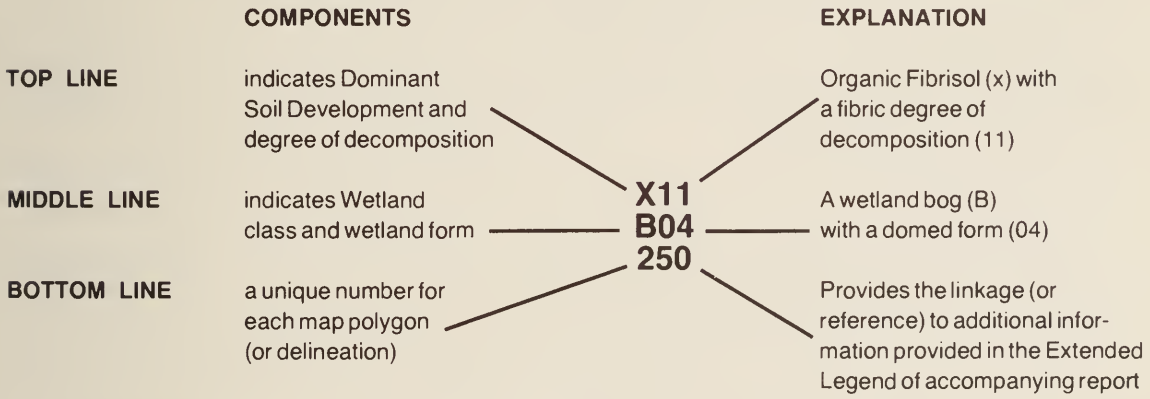
soil development	because it indicates likely natural fertility, internal drainage, alkalinity, and reaction (or acidity)
texture group of parent material	because it influences the capacity of the parent soil to store moisture and to make moisture available to plants, and, in the case of sandy soils, their susceptibility to wind erosion
origin of parent material (mode of deposition)	because it provides information of the surficial geology and a linkage to mapping methods used on the source maps
surface form	because it influences soil development, land use, and surface drainage
slope class	because it influences land use and water erosion risk, particularly when coupled with long slopes on inclined or rolling surfaces

MAP SYMBOL FORMAT

(a) Format for mineral soils



(b) Format for organic soils



(c) Format for Rockland

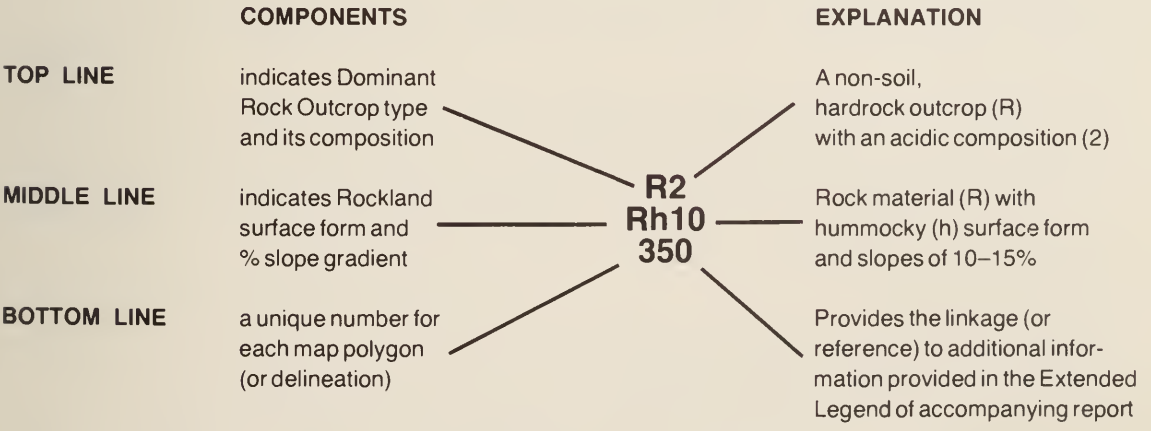


Fig. 2 Explanation of map symbols.

kind of rock outcrop (acidic or basic property)	because it influences the chemistry of the drainage water and plant or aquatic growth
unique polygon number	because it provides a means of labeling each area

Additional attributes The following attributes are required for more specialized assessments and interpretations. Some of these attributes will be published with the maps and reports. However, they can all be obtained on diskettes in ASCII format with supporting documentation. The detailed computerized legend includes as a minimum, besides the major attributes, the following attributes for dominant and subdominant soil landscapes:

- percentage distribution of soil landscapes
- grid code for locating polygons
- regional landform
- parent material texture
- surface texture of mineral soil to 15 cm
- coarse fragment content in control section
- rooting depth, unrestricted
- kind of compacted, consolidated, or contrasting layer
- depth to compacted, consolidated, or contrasting layer
- drainage
- available water-holding capacity in upper 120 cm
- depth to water table
- dominant type of ice
- ice content
- permafrost occurrence
- depth of active layer in permafrost soils
- kind of patterned ground
- pH of upper 15 cm of soil horizon ($CaCl_2$)
- pH of upper 15 cm of soil horizon (water)
- organic carbon content of upper 15 cm of soil
- nitrogen content of upper 15 cm of soil
- thickness of humus layer
- calcareous class of parent material
- inclusion 1
- inclusion 2
- vegetation cover and/or land use class
- lake size
- water bodies wholly contained in the polygon (percentage coverage)
- reliability class
- complexity class
- soil name 1
- soil name 2
- area of polygon (kilohectares)

The attributes were then arranged and listed in a computerized extended legend file structure applying to the dominant soil landscape occurring within each polygon. The same file structure was also used for attributes

applying to the subdominant soil landscape, when present, in a polygon. This extended legend file makes it possible to systematically compile much more information than that which can be shown on the map symbol or on the map legend, or in the report accompanying the map. Fig. 3 is an example of the coding form used for compiling the detailed computerized extended legend attributes.

Map compilation

Procedures used where source maps exist It is advised that the following steps be taken when maps are compiled from existing soil maps and legends:

- In compiling generalized small-scale maps, use the most recently available, larger-scaled, soil survey source maps and their reports.
- Establish the size of area at the source map scale that reduces to 1 × 1 cm (100 km^2) at a scale of 1:1 million. This area was selected as the smallest mappable area; most areas will be larger. However, a few exceptions exist where generalized map polygons at 1:1 million scale may be smaller than 1 cm^2 such as narrow, elongated features and drainage patterns, strongly contrasting soil landscapes, and small islands. Attach map symbols to these smaller polygons by use of a leader, assuming the polygon density adjacent to these areas has room for the extra symbol and leader.
- Overlay and register translucent material with a matte surface (Chronoflex) to the soil survey source map.
- Delineate the major drainage pattern and other major physiographic features on the source map. Avoid making the drainage pattern too detailed, because drainage often bisects soil landscape areas thereby greatly increasing the number of polygons required.
- Delineate large, uniform, soil landscape areas on the source map.
- Translate the source map symbol and legend information to the generalized small-scale map symbol format and assign a unique polygon number. A change in at least one differentiating property class limit on the source map results in a separate generalized polygon.
- Where necessary, group smaller source map polygons that are most similar thereby aggregating areas to form a composite dominant portion of the generalized polygon; compose its map symbol and assign a unique polygon number.
- If necessary, group source map polygons that are dissimilar and proceed as already indicated.
- Continue the same procedure until most areas of the source map are generalized. Review any remaining small areas and decide with which generalized polygons they should most sensibly be combined.
- Review the generalized polygons and their map symbols, and compare them with the source information.

```
SOIL LANDSCAPES OF CANADA                                                        - PRINTED 91.07.02    PAGE  1
DOMINANT ATTRIBUTES  -  DETAILED COMPUTERIZED LEGEND  (PHASE 2)     -      LAST UPDATE  91-06-14
           (ATTRIBUTE CLASS CODES ARE DESCRIBED IN SOIL LANDSCAPES OF CANADA PROCEDURES MANUAL AND USERS HANDBOOK)
P   P    D  D   G   D D  D D  D   D D   D D  D D D D D D D D D  D  D  D  D  D D D D  D  D  D D D D D     D     D
R   O    O  O   R   O O  O O  O   O O   O O  O O O O O O O O O  O  O  O  O  O O O I  I  O  O O O O O     O     O
O   L    M  M   I   M M  M M  M   M M   M M  M M M M M M M M M  M  M  M  M  M M M N  N  M  M M M M M     M     M
V   Y    K  D   D   R L  S P  P   D S   C R  C C D A W I I P A  P  P  P  O  N H C C  C  V  L W R C N     N     T
I   N    D  I   L   E O  L M  M   E R   F O  M M R V A C C E C  A  H  H  R  I U A L  L  E  A A E O A     A     E
N   U    M  S   O   G C  O D  T   V F   R O  P P A W T E E R T  T  C  W  G  T M L U  U  G  K T L M M     M     X
C   M    A  T   C   F S  P E  E   E T   A T  L D I A A T C M L  G  A  A  A  R L C S  S  E  E B I P E     E     G
E   B    T  R   N   M F  E P  X   L X   G    R P N T B Y T A R  D  L  T  N  O R A 1  2  T    D A L 1     2     P
XXX 0000 XX XXX XXX X XXX X XX XXXX X XXXX X XXX X X X X X X X X XXX XX XX XX XX X X X XX XX XX X X X X XXXXXX XXXXXX XX
```

Fig. 3 Detailed computerized legend coding form (dominant attributes).[1]

[1] For convenience of displaying the coded data, spaces were inserted between the attributes. The attribute sequence is similar to that given by the dominant soil attribute list. However, the column numbers differ because of the inserted spaces.

- Code attributes applying to the dominant soil landscape portion of the generalized polygon on the detailed computerized legend (Phase 2) coding form (Fig. 3); repeat for compilation of attributes applying to the subdominant soil landscape portion of the polygon, when present, as listed in the detailed computerized legend.
- Correlate polygon boundaries along adjacent source maps and also along provincial boundaries.
- Reduce the compiled maps on the matte surface overlays photomechanically to 1:1 million scale; process them onto clear material; then mozaic and register them to an appropriate 1:1 million scale base.
- Edit this mozaic carefully to ensure that all boundaries and map symbols are correlated.
- If small islands in the coastal areas are a problem, recognize an island with a minimum size of 0.25 cm^2 and code it as a polygon. Where small islands are situated close together in a group, draw a line around them to form a polygon. Estimate the portion of such a polygon that is water and indicate it as a percentage on the coding form.
- Prepare a map positive at a scale of 1:1 million.

Procedures used where no source maps exist At present, little or no soil information is available for most northern areas where soil surveys are yet to be carried out. Examples of these areas include Yukon Territory, Northwest Territories, and parts of northern British Columbia, Ontario, Quebec, and Labrador. In many cases there is also a lack of geomorphological data concerning such features as regional landforms, surficial materials, and local surface forms. This lack of information and the inaccessibility of the terrain requires the development of survey methodology, to provide both detailed information on a site-specific basis and general information in the form of small-scale soil landscape maps based on LANDSAT imagery (Tarnocai 1977). This mapping is conducted most efficiently when it is carried out by a pedologist experienced in the northern environment.

The following survey methodology is proposed for areas where no source maps exist:

- Arrange to acquire or have compiled a suitable base map for the project area, at a scale of 1:1 million.
- Compile the map using 1:1 million-scale, cloud-free, high-quality LANDSAT imagery, which is interpreted manually and with the aid of panchromatic photographs.
- Interpret features most readily and consistently observable on LANDSAT imagery including regional landforms, surficial materials, local surface form, occurrence and size of water bodies, wetlands, vegetation, and patterned ground.
- Overlay and register translucent matte surface material (Chronoflex) on the selected LANDSAT image.

- Pretype (or interpret) the imagery in the office by delineating regional landforms and major drainage features to form enclosed map polygons.
- Subdivide these relatively large polygons into smaller polygons dominated by similar surficial material, surface form, patterned ground, slope gradient, wetland type, and water body composition.
- Assign a unique number to each polygon; assignment of a map symbol is optional.
- Make the smallest polygon mapped at least 1 × 1 cm in size; exceptions include small islands or distinct, elongated soil landscape features.
- Complement the interpretation of LANDSAT imagery features with the use of available panchromatic photos to provide or define additional interpretable features and revise polygon boundaries accordingly.
- Correlate polygon boundaries and differentiating attribute features from a completed image to an adjoining image; complete for all images in the project area.
- Review pretyped map and plan the efficient use of fixed-wing (or helicopter) traverses throughout the area; select suitable landing locations from which to conduct ground traverses.
- Conduct planned air traverses to verify the characteristic features and their composition in the pretyped polygons; make corrections where pretyping interpretations do not agree with what is observed from the air.
- Assign decile proportions both to the dominant and subdominant soil landscapes applying to the map polygon, and to the inclusions.
- During ground stops, collect detailed information relating to terrain and vegetation; sample and describe soils; collect as much detailed information as possible at these sampling sites (not merely general information) because these data are often the *only* data available for the soils, terrain, and vegetation of the area.
- Compile attributes applying to the dominant soil landscape portion of the polygon on the detailed computerized legend (Phase 2) coding form (Fig. 3); repeat for compilation of attributes applying to the subdominant soil landscape portion of the polygon, if present.
- Transfer finalized map polygons from Chronoflex overlay on LANDSAT imagery to the base map; label polygons with a unique number (and map symbol if desirable) and submit to Cartographic Section, LRRC, for map production.

Correlation procedures and quality control Correlation is the process of maintaining consistency and quality control in compilation of maps of different areas and in compilation of the extended legend attribute classes.

Map compilers For the map compiler, correlation requires consistent translation and coding of attributes that apply to the dominant, subdominant, and inclusion portions of the generalized polygon,

particularly in cases where the generalized map polygon comprises two or more source map polygons.

Provincial project leaders Provincial project leaders are responsible for correlation activities to resolve differences in map symbols and generalized polygon boundaries on adjacent source maps within a province or between provinces. These discrepancies arise from differences in source map scale, intensity of inspections, and soil classification systems used.

Resolution is achieved by carefully reviewing the information given on the source map legend and report (mapping methodology, kind and scale of aerial photographs, and classification system) so that consistent translation of source information to general polygon attributes is achieved among different map compilers. Attribute files must also be reviewed to eliminate coding placement errors. These types of quality control provide credibility and confidence in the resultant files.

National project leader Consistent adherence to nationally established attribute class limits by map compilers in different provinces is the responsibility of the national project leader. This consistency is achieved by preparing procedures manuals, conducting training sessions with provincial project leaders, or compiling maps of selected map areas within a province for use as training areas. Requests for the establishment either of additional attribute classes or of new attributes are also reviewed and appended where necessary.

In cooperation with CanSIS and cartographic personnel, national project leaders ensure that

- data on coding forms are validated and input to the national soil data base archive of CanSIS
- map legends are compiled
- derivative maps are produced
- a national data base management system is developed.

In northern terrain studies it is important that both field work and interpretation be carried out by *people having several years experience* to ensure high-quality and cost-efficient mapping. With this approach, maximum use can be made of both remote sensing and ground verification data, with minimal on-site correlation.

Workshops reviewing mapping methodology, data coding, and correlation procedures for project areas are organized when required.

Description of complex map polygons When a polygon was found to contain very different types of soil or important inclusions, the two most prominent soil landscapes (dominant and subdominant) are presented, as well as the inclusions. The proportions of the dominant and subdominant soil landscapes and inclusions in any one polygon (common to all maps and all polygons) are assigned as follows:

One soil landscape without or with inclusions	Dominant represents the entire area; for calculations, assume 100% but, if inclusions are present, assume the dominant soil to represent 85% and the inclusions 15%
Two soil landscapes	For calculations, assume the dominant soil to represent 70% and the subdominant soil 30%
Two soil landscapes and inclusions	For calculations, assume the dominant soil to represent 60%, the subdominant soil 25%, and the inclusions 15%.

Explanation of map symbols and colors There is one map symbol for each polygon. The map legend explains the abbreviations used in the top and middle lines of each map symbol. The top line of the map symbol (Fig. 2), which specifies the soil development and texture grouping of the polygon, determines the color of each map polygon. Each type of soil development is assigned a unique color. Three shades of this color are then used to indicate the various texture groupings of each type of soil development. Lighter shades are used for the grouping of sand and sandy loam textures, intermediate shades are used for the grouping of loams and clay loams, and the darker or most intense shades are used for the clays.

Updating map information As new information becomes available (for example, when a soil map for a previously unsurveyed area is produced), the attributes and eventually the soil landscape boundaries will be revised. The revisions will be recorded in the computerized data base stored in CanSIS. New maps will not be regularly published. Therefore, the information in CanSIS will be kept more up-to-date than the published maps. Hard copies of both the maps and the attributes stored in CanSIS can be supplied on request. The detailed computerized legends will also be made available on request.

Dominant and subdominant soil landscape files: attribute list and structure[1]

Class no.	Attribute	Type	Width	Dec	Column number	Assigned attribute names
01	Provincial code (Cols. 1–2) and map sheet number (Col. 3)	C	3	-	1–3	PROVINCE
02	Polygon number	C	4	-	4–7	POLYNUMB
03	Kind of rock outcrop or other material at the surface	C	2	-	8–9	DOMKDMAT
04	Percentage distribution of soil landscapes	C	3	-	10–12	DOMDISTR
05	Grid code for locating polygons	C	3	-	13–15	GRIDLOCN
06	Regional landform	C	1	-	16	DOMREGFM
07	Local surface form	C	3	-	17–19	DOMLOCSF
08	Slope gradient class	C	1	-	20	DOMSLOPE
09	Parent material mode of deposition	C	2	-	21–22	DOMPMDEP
10	Parent material texture	C	4	-	23–26	DOMPMTEX
11	Soil development	C	1	-	27	DOMDEVEL
12	Surface texture of mineral soil to 15 cm	C	4	-	28–31	DOMSRFTX
13	Coarse fragment content in control section	C	1	-	32	DOMCFRAG
14	Rooting depth, unrestricted	C	3	-	33–35	DOMROOT
15	Kind of compacted, consolidated, or contrasting layer	C	1	-	36	DOMCMPLR
16	Depth to compacted, consolidated, or contrasting layer	C	1	-	37	DOMCMPDP
17	Drainage class	C	1	-	38	DOMDRAIN
18	Available water capacity in upper 120 cm	C	1	-	39	DOMAVWAT
19	Depth to water table, average	C	1	-	40	DOMWATAB
20	Ice type	C	1	-	41	DOMICETY
21	Ice content	C	1	-	42	DOMICECT
22	Permafrost occurrence	C	1	-	43	DOMPERMA
23	Active layer depth in soils with permafrost	C	3	-	44–46	DOMACTLR
24	Kind of patterned ground in soils with permafrost	C	2	-	47–48	DOMPATGD
25	pH of upper 15 cm of soil ($CaCl_2$)	C	2[2]	-	49–50	DOMPHCAL
26	pH of upper 15 cm of soil (water)	C	2[2]	-	51–52	DOMPHWAT
27	Organic carbon of upper 15 cm	C	2[2]	-	53–54	DOMORGAN
28	Nitrogen content of upper 15 cm of soil	C	1	-	55	DOMNITRO
29	Thickness of humus layer	C	1	-	56	DOMHUMLR
30	Calcareous class of parent material	C	1	-	57	DOMCALCA
31	Inclusions 1	C	2	-	58–59	DINCLUS1[3]

(continued)

(concluded)

Class no.	Attribute	Type	Width	Dec	Column number	Assigned attribute names
32	Inclusions 2	C	2	-	60-61	DINCLUS2[3]
33	Vegetative cover and/or landuse	C	2	-	62-63	DOMVEGET
34	Lake size from LANDSAT	C	1	-	64	DOMLAKE
35	Water bodies from LANDSAT as percentage of polygon	C	1	-	65	DOMWATBD
36	Reliability class of polygon	C	1	-	66	DOMRELIA
37	Complexity class of polygon	C	1	-	67	DOMCOMPL
38	Soil name 1	C	6	-	68-73	DOMNAME1
39	Soil name 2	C	6	-	74-79	DOMNAME2
40	Parent material textural group (as shown in map symbol)	C	2	-	80-81	DOMTEXGP[4]
41	Area of polygon (kilohectares)	N	7	1	82-88	AREAKHA

[1] For subdominant attribute names, replace DOM with SUB.
[2] To avoid coding a decimal point, data for pH in $CaC1_2$ and water were each compiled in a two-column field (e.g., 67 means a pH of 6.7).
[3] Subdominant inclusions attribute names are SINCLUS1 and SINCLUS2.
[4] No SUBTEXGP is recorded.

Dominant and subdominant soil landscape files: attributes, their classes, codes, and descriptors

It is mandatory to compile classes for all dominant and subdominant attributes (01-41) unless they either do not occur or are not applicable, in which case one of the following conventions is used:

- Code a dash (-) to indicate the attribute does not occur as in the case where the subdominant soil landscape is absent.
- Use the character # to indicate the attribute is not applicable to describing the dominant or subdominant soil landscape.

01 Provincial code (Cols. 1-2)[1] **and map sheet number** (Col. 3)

Enter the code and the sheet number:

Provincial code	*Map name*	*Sheet number*
BC	British Columbia—South	1
	—North	2
AL	Alberta	1
SK	Saskatchewan	1

[1] Column numbers here correspond to those given in the attribute list.

MN	Manitoba	1
ON	Ontario—South	1
	—North	2
QU	Quebec—Southwest	1
	—Southeast	2
	—Central	3
	—North	4
NB	New Brunswick[2]	1
NS	Nova Scotia[2]	1
PE	Prince Edward Island[2]	1
NF	Newfoundland—South	1
	—North	2
YU	Yukon	1
NW	Northwest Territories	1 to 9.

02 Polygon number (Cols. 4–7)

Enter the number.

03 Kind of rock outcrop or other material at the surface (Cols. 8–9)

Enter the code:

Code	*Class*	*Description*
IC	Ice and snow	Ice and snow
OR	Organic soil	Contains >30% organic matter by weight
R1	Soft rock, undifferentiated	Rock that can be dug with a shovel, e.g., shales, upper Cretaceous, and Tertiary materials
R2	Hard rock, acidic	Granite
R3	Hard rock, carbonaceous	Limestone
R4	Hard rock, undifferentiated	Hard rock of unspecified origin and properties
SO	Mineral soil	Dominantly mineral particles, contains <30% organic matter by weight
WA	Water	Water
UR	Urban	Urban areas. *Note*: only a few major urban area polygons are shown on maps; do not use for tabulating urban areas.

[2] For map, see *Soil landscapes of Canada, Maritime Provinces*; for extended legend see *Soil landscapes of Canada: Maritimes*.

04 Percentage distribution of dominant and subdominant soil landscapes (Cols. 10–12)

Enter the percentage number. If no source information is available on the distribution, enter general distribution; i.e., 70% for dominant and 30% for subdominant where both occur without inclusions, and 100% where only a dominant soil landscape occurs.

05 Grid code for locating polygons (Cols. 13–15)

Enter the code. Each section of the grid covers 1° latitude by 2° longitude on the map area. The grid code consists of a letter (north axis) followed by a number (west axis). The grid codes and the map reliability are shown in the margins of the published map.

06 Regional landform (Col. 16)

(*Refs*. Geoanalysis Ltd. 1981; United States Department of Agriculture 1986)

Enter the code. General physical descriptions define classes of regional landforms each represented by a code as follows:

Code	*Class*	*Description*
B	Tableland (or plateau) dominated	Comparatively flat areas of great extent commonly bounded on at least one side by an abrupt escarpment, or may be terminated by mountains; may be dissected by deep valleys and deeply incised rivers; may be tectonic, erosional, or volcanic in origin; may be step-faulted; slopes generally <10%, in some places 10–15%; relief generally <50 m
H	Hilland dominated	Natural elevations rising prominently above the surrounding plain and having a recognizably denser pattern of generally higher knolls or crest lines with an irregular or chaotic surface form composed of upper surface convexity and lower concavity; includes hummocky morainal material, volcanic cones, and conical hills of lava; slopes generally 10–30%; relief generally <100 m
M	Mountain dominated	Erosional and volcanic landscapes with relief (vertical distance between higher and lower parts) ≥300 m with

		most of the area comprising valley to summit terrain; slopes generally >30%. In general the terrain has a restricted summit area and steep sides, irregular shape and considerable bare rock surface, or very thin soil cover; occur as a single, isolated feature or in a group forming a long chain or range; major scarps are relatively steep and straight cliff-like slopes of considerable linear extent separating surfaces such as plateaus lying at different levels
O	Organic wetland dominated	Areas dominated by organic material >40 cm thick; contains >30% organic matter by weight; occurs in a variety of wetland surface forms
P	Plain dominated	Flat to very gently undulating areas having few or no prominent irregularities; formed by erosional or by depositional (or constructional) processes; include broad, continuous, gently sloping piedmont plains extending along and from the base of a mountain, formed by lateral coalescence of a series of separate but confluent alluvial fans; alluvial processes are mainly responsible for the sedimentation; coarse fragments are rounded by transport over relatively long distances; slopes generally <6%; relief generally <10 m; extent generally >5 km in one direction
S	Scarp dominated	An escarpment, cliff, or steep slope of some extent along the margin of a terrace, bench, plateau, hill, or mesa; a scarp may be of any height
V	Valley dominated	Terrain dominated by major spillways, drainageways, or mountain trenches separated from surrounding landforms by a *significant and abrupt break in slope*; the valley profile may be V- or U-shaped with an extensive valley floor and flood plain up to about

		5 km wide; valley profile may also include eroded terraces and their irregular slope segments.
#	Non applicable	(Urban area).

07 Local surface form (Cols. 17–19)

(*Refs.* Agriculture Canada Expert Committee on Soil Survey 1987; National Wetlands Working Group 1987)

Enter the code. Descriptions define classes of local physical surface forms (assemblage of slopes) or recurring pattern of forms occurring at the earth's surface. When applied to consolidated materials, form refers to the product of their modification by geological processes. Select only one code per soil landscape, either from mineral surface forms or from wetland surface forms.

Mineral surface forms

Code	*Class*	*Description*
D	Dissected (Fig. 4)	A dissected (or gullied) pattern providing external drainage for an area
H	Hummocky (or irregular) (Fig. 5)	A very complex sequence of slopes extending from somewhat rounded concavities (or swales) of various sizes to irregular, conical knolls (or knobs) and short, discontinuous ridges; there is a general lack of concordance between knolls and swales; slopes are 4–70%; examples: examples: hummocky moraine, hummocky fluvioglacial
I	Inclined	A sloping, unidirectional surface with a generally constant slope not broken by marked irregularity or gullies; a weakly developed pattern provides external drainage for the local area; slopes are 2–70%; the form of inclined slopes is not related to the initial mode of origin of the underlying material
K	Knoll and kettle (Fig. 6)	A very chaotic sequence of knolls and numerous kettles (or sloughs), which occupy 15–20% of an area and which have no external drainage; slopes are generally >3%; examples: morainal plains and hillands

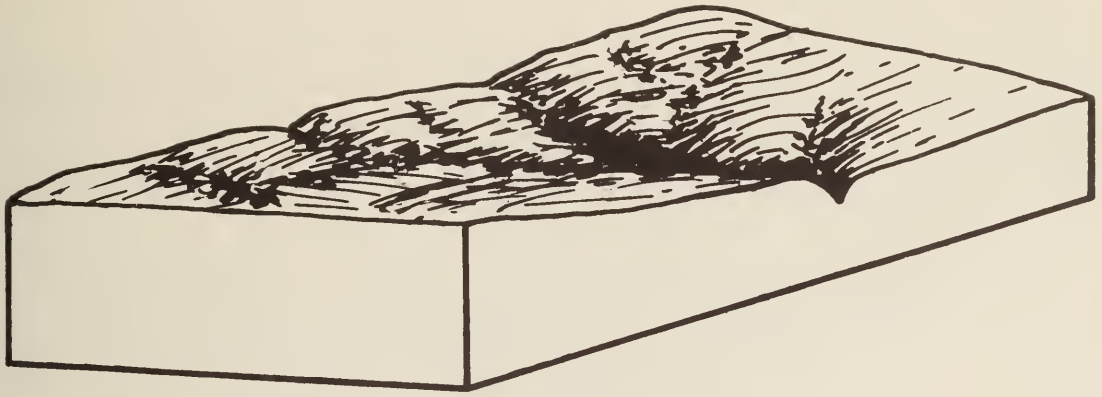


Fig. 4 Dissected surface form.

Fig. 5 Hummocky surface form.

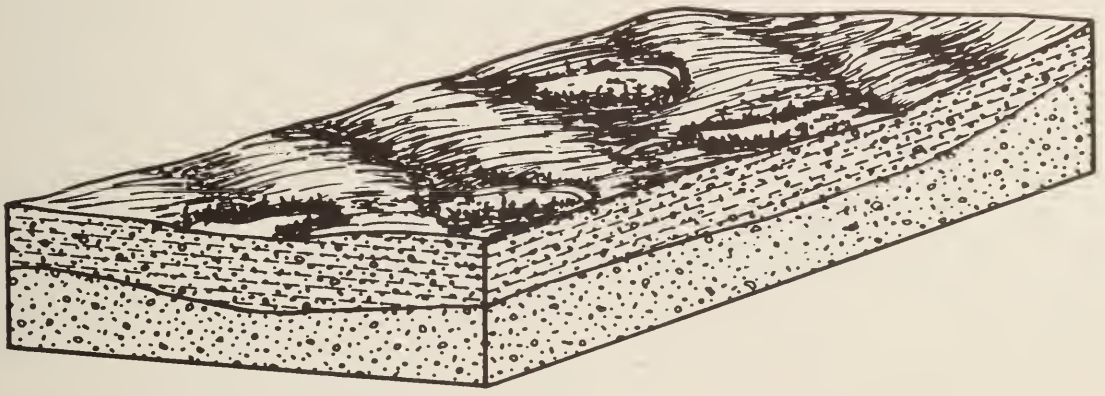


Fig. 6 Knoll-and-kettle surface form.

L	Level	A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions; slopes are generally <2% (i.e., 1%); examples: floodplain, lake plain
M	Rolling (Fig. 7)	A very regular sequence of moderate slopes extending from rounded and, in some places, confined concave depressions to broad, rounded convexities producing a wavelike pattern of moderate relief; slope gradients are generally >5% but may be less; this surface form is usually controlled by the underlying bedrock
R	Ridged (Fig. 8)	A long, narrow elevation of the surface, usually distinctly crested with steep sides; ridges may be parallel, subparallel, or intersecting; examples: eskers, crevasse fillings, washboard moraines, some drumlins
S	Steep (Fig. 9)	Erosional slopes >70%, on both consolidated and unconsolidated materials; form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material; example: escarpments
T	Terraced	Scarp face and the horizontal or gently inclined surface (or tread) above it; example: alluvial terrace
U	Undulating (Fig. 10)	A very regular sequence of gentle slopes that extends from rounded and, in some places, confined concavities to broad, rounded convexities producing a wavelike pattern of low local relief; slope length is generally <0.8 km and the dominant gradient of slopes is usually 2–5%; it lacks an external drainage pattern; examples: some ground moraine, lacustrine material of varying texture.

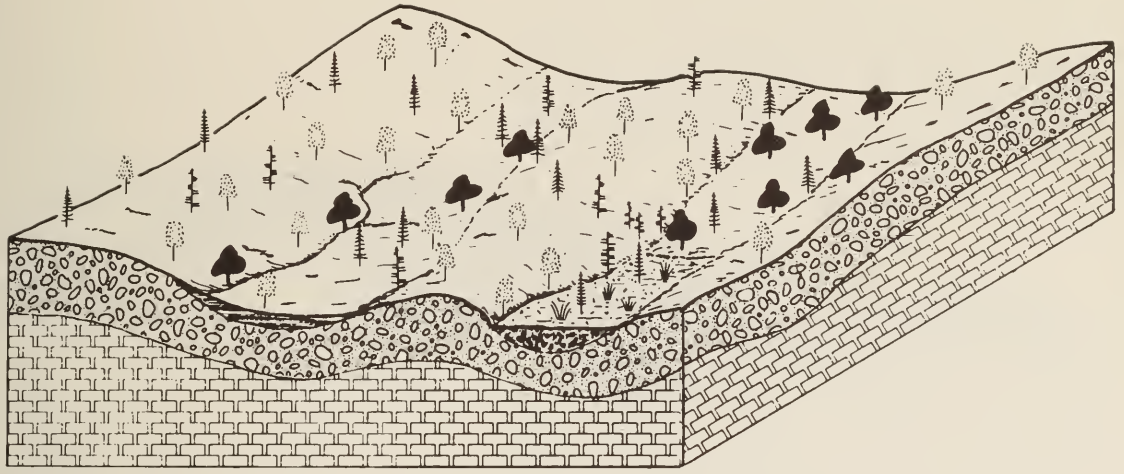


Fig. 7 Rolling surface form.

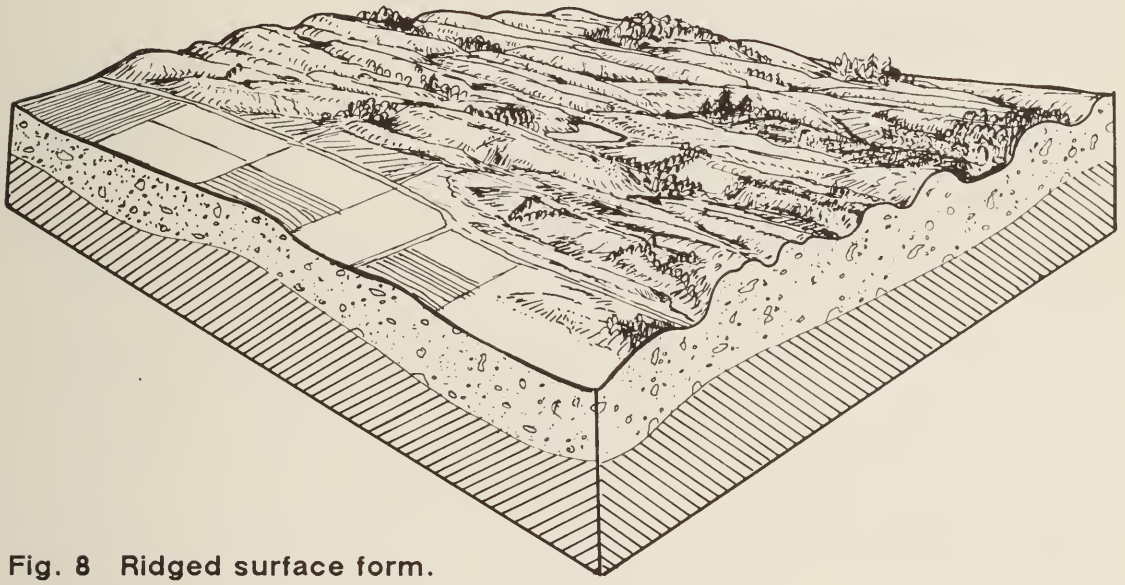


Fig. 8 Ridged surface form.

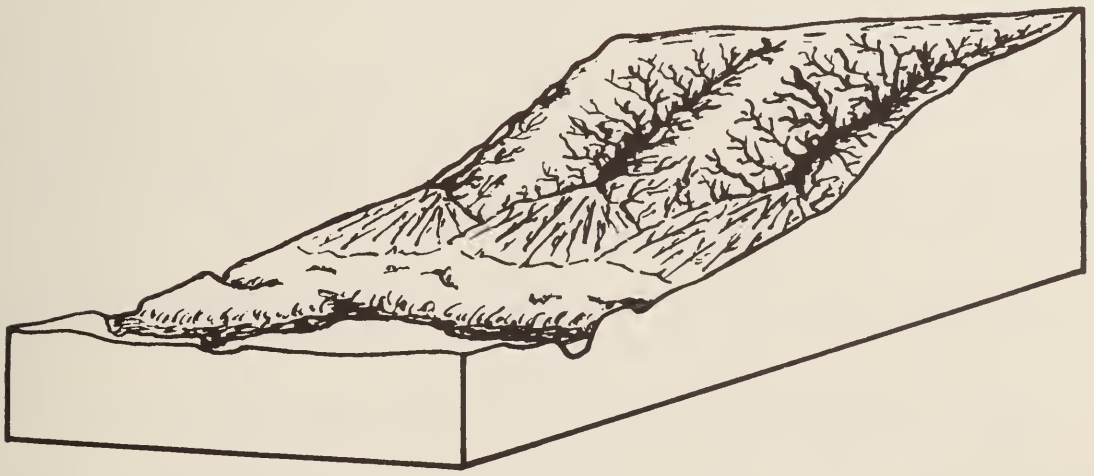


Fig. 9 Steep surface form.

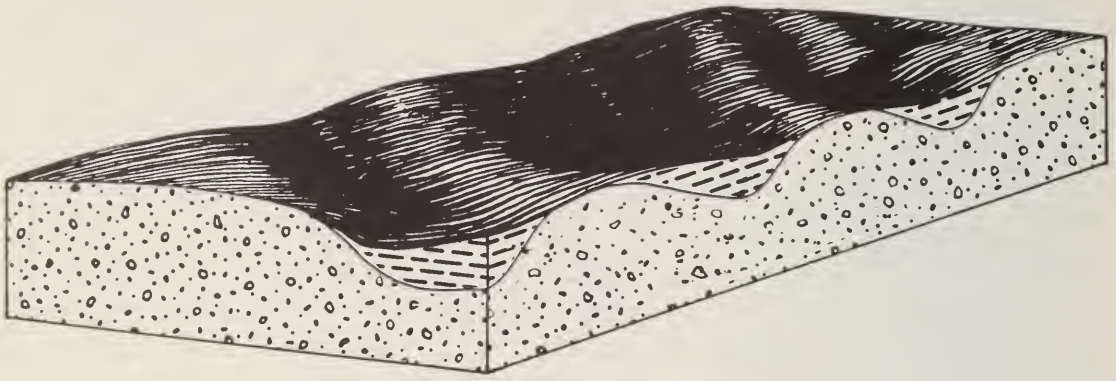


Fig. 10 Undulating surface form.

Wetland surface forms

Code	*Class*	*Description*
B04	Domed bog	A large (diameter usually >500 m) bog with a convex surface, rising several metres above the surrounding terrain; centre usually drains in all directions; small crescentic pools commonly form around the highest point; if the highest point is in the centre, the pools form a concentric or, if the pattern is off-centre, an eccentric pattern; the peat development is usually >3 m
B05	Polygonal peat plateau bog	A perennially frozen bog, rising about 1 m above the surrounding fen; the surface is relatively flat, scored by a polygonal pattern of trenches that developed over ice wedges; the permafrost and ice wedges developed in peat originally deposited in a nonpermafrost environment
B07	Peat plateau bog	A bog composed of perennially frozen peat, rising abruptly about 1 m from the surrounding unfrozen fen; the surface is relatively flat and even, and commonly covers large

		areas; the peat was originally deposited in a nonpermafrost environment and is associated in many places with collapse scar bogs or fens
B09	Atlantic plateau bog	A bog with a flat-to-undulating surface raised above the surrounding terrain, with the bog edges commonly sloping steeply down towards the mineral soil terrain; large pools scattered on the bog reach a depth of 2–4 m
B13	Basin bog	A bog situated in a basin that has an essentially closed drainage, receiving water from precipitation and from runoff from the immediate surroundings; the surface of the bog is flat, but the peat is generally deepest at the centre
B14	Flat bog	A bog having a flat, featureless surface and occurring in broad, poorly defined depressions; the depth of peat is generally uniform
B15	String bog	A pattern of narrow (2–3 m wide), low (<1 m deep) ridges oriented at right angles to the direction of drainage; wet depressions or pools occur between the ridges; the water and peat are very low in nutrients, as the water has been derived from other ombrotrophic wetlands; peat thickness >1 m
B16	Blanket bog	A bog consisting of extensive peat deposits that occur more or less uniformly over gently sloping hills and valleys; the peat thickness is usually <2 m
B18	Slope bog	A bog occurring in areas of high rainfall on appreciably sloping land surfaces, fed by rainwater and by water draining from other nutrient-poor wetlands; the peat may exceed 1 m in thickness
B19	Veneer bog	A bog occurring on gently sloping terrain underlain by generally discontinuous permafrost; although drainage is predominantly below the surface, overland flow occurs in

		poorly defined drainageways during peak runoff; peat thickness is usually <1.5 m
F01	Northern ribbed fen	A fen with parallel, low peat ridges ("strings") alternating with wet hollows or shallow pools, oriented across the major slope at right angles to water movement; the depth of peat is >1 m
F07	Shore fen	A fen with an anchored surface mat that forms the shore of a pond or lake; the rooting zone is affected by the water of the lake at both normal and flood levels
F11	Slope fen	A fen occurring mainly on slow-draining, nutrient-enriched seepage slopes; pools are usually absent, but wet seepage tracks may occur; peat thickness usually <2 m
F13	Horizontal fen	A fen with a very gently sloping, featureless surface; this fen occupies broad, often ill-defined depressions and may interconnect with other fens; peat accumulation is generally uniform
S01	Stream swamp	A swamp occurring along the banks of permanent or semipermanent streams; the high-water table is maintained by the level of water in the stream; the swamp is seasonally inundated, with subsequent sediment deposition
S04	Basin swamp	A swamp developed in a topographically defined basin where water derived locally may be augmented by drainage from other parts of the watershed; accumulation of well-decomposed peat is shallow (<0.5 m) at the edge and may reach 2 m at the centre
M06	Stream marsh	A marsh occupying shorelines, bars, streambeds, or islands in continuously flowing water courses; the marsh is subject to prolonged annual flooding and is commonly covered by thick layers of sediments

M11	Shallow basin marsh	A marsh occurring in a uniformly shallow depression or swale, having a gradual gradient from the edge to the deepest portion; the marsh edge may be poorly defined; water levels fluctuate rapidly
M14	Shore marsh	A marsh occupying the contact zone between high and low water marks bordering semipermanent or permanent lakes; the marsh is usually found along protected shorelines, in lagoons behind barrier beaches, on islands, or in embayments; the marsh is subject to flooding by rise in lake levels, wind, waves, or surface runoff.
#	Non applicable	(Urban area).

08 Slope gradient class (Col. 20)

(*Ref.* Shields 1982)

Enter the code:

Code	*Class*
A	1–3% (includes slopes <1%)
B	4–9%
C	10–15%
D	16–30%
E	31–60%
F	>60%
#	Non applicable (water).

09 Soil parent material mode of deposition (or origin) (Cols. 21–22)

(*Refs.* Tarnocai 1984; Agriculture Canada Expert Committee on Soil Survey 1987; National Wetlands Working Group 1987)

Enter the code. The mode of deposition of mineral materials and undifferentiated organic materials is shown by a single alpha code whereas the origin of specified organic material is given by a numeric, two-digit code.

Mineral materials and undifferentiated or unspecified organic materials

Code	*Class*	*Description*
A	Alluvial	Sediment generally consisting of gravel and sand with a minor fraction of silt and clay; gravels are

		typically rounded and contain interstitial sand; alluvial sediments are commonly moderately to well sorted and display stratification; examples: channel deposits, overbank deposits, terraces, alluvial fans, and deltas
B	Bog	Bogs consist of unspecified organic materials associated with an ombrotrophic environment because the slightly elevated nature of the bog dissociates it from nutrient-rich ground water or surrounding mineral soils; near the surface, materials are usually undecomposed (fibric), yellowish to pale brown, loose and spongy in consistence, and entire sphagnum plants are readily identified; these materials are extremely acid, with low bulk density and high fiber content; at depths they become darker, compacted, and somewhat layered; bogs are associated with slopes or depressions on topography with a water table at or near the surface in the spring and slightly below it during the rest of the year; they are usually covered with sphagnum mosses, but sedges may also grow on them; bogs may be treed or treeless and many are characterized by a layer of ericaceous shrubs
C	Colluvial	Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders that have reached their present position only by direct, gravity-induced movement (excepting snow avalanches); processes include slow displacements such as creep and solifluction and rapid movements such as earth flows
D	Residual	Unconsolidated, weathered, or partly weathered soil mineral material that accumulates by disintegration of bedrock in place

E	Eolian	Sediment, generally consisting of medium-to-fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive; individual grains may be rounded and show signs of frosting; these materials have been transported and deposited by wind action; examples: dunes, shallow deposits of sand and coarse silt, and loess but not tuffs
F	Fluvioglacial	Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice; deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces
H	Marsh	Mineral wetland or wetland that is periodically inundated by standing or slow-moving water; surface water levels may fluctuate seasonally, with declining levels exposing drawdown zones of matted vegetation or mudflats; waters are rich in nutrients, varying from fresh to highly saline; substratum usually consists of mineral material, although in some places it consists of well-decomposed peat; soils are predominantly Gleysols, with some Humisols and Mesisols; marshes characteristically show zonal or mosaic surface patterns composed of pools or channels interspersed with clumps of emergent sedges, grasses, rushes, and reeds, bordering grassy meadows and peripheral bands of shrubs or trees; submerged and floating aquatics flourish where open-water areas occur
L	Lacustrine	Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed or moderately well sorted and stratified

		sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action; these materials either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action; examples: lake sediments and beaches
M	Morainal	Sediment generally consisting of well-compacted material that is nonstratified and contains a heterogeneous mixture of sand, silt, and clay particle sizes and coarse fragments in a mixture that has been transported beneath, beside, on, within, or in front of a glacier and not modified by any intermediate agent; examples: basal till (ground moraine), lateral and terminal moraines, rubbly moraines of cirque glaciers, hummocky ice-disintegration moraines, and preexisting, unconsolidated sediments reworked by a glacier so that their original character is largely or completely destroyed
N	Fen	Fens consist of unspecified organic materials formed in a minerotrophic environment because of the close association of the material with mineral-rich waters; it is usually moderately well to well decomposed, dark brown to black, with fine- to medium-sized fibers; decomposition commonly becomes greater at lower depths; the materials are covered with a dominant component of sedges, but grasses and reeds may be associated in local pools
O	Organic, undifferentiated	A layered sequence of more than three types of organic material (>30% organic matter by weight)

R	Rock	A consolidated bedrock layer that is too hard to break with the hands (>3 on Mohs' scale) or to dig with a spade when moist
S	Swamp	Minerotrophic wetlands with the water table at or above the peat surface; dominant unspecified organic materials are forest and fen peat formed in a eutrophic environment because of strong water movement from the margins or other mineral sources; it is usually moderately well to well decomposed and has a dark brown to reddish brown matrix; the more decomposed materials are black; it has an amorphous or very fine-fibered structure containing a random distribution of woody fragments and trunks of coniferous tree species; the vegetation cover may consist of coniferous or deciduous trees, tall shrubs, herbs, and mosses; in some regions sphagnum mosses are abundant
T	Anthropogenic	Materials modified by people, including those associated with mineral exploitation and waste disposal; they include materials deposited as a result of human activities or geological materials modified artificially so that their physical properties (structure, cohesion, compaction) have been drastically altered; examples: areas of landfill, spoil heaps, open-pit mines, leveled irrigated areas
U	Undifferentiated	A sequence of more than three types of genetic mineral materials outcropping on a steep erosional escarpment; this complex class is to be used where units relating to individual genetic materials cannot be delimited separately at the scale of mapping; it may include colluvium derived from the various genetic materials and resting upon the scarp slope

V	Volcanic	Volcanic pumice and ash
W	Marine	Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well to moderately well stratified (in some places containing shells); they have settled from suspension in salt or brackish water bodies or have accumulated at their margins through shoreline processes such as wave action and longshore drift; nonfossiliferous deposits may be judged marine, if they are located in an area that might reasonably be considered to have contained salt water at the time the deposits were formed.

Specified organic materials

Code	*Class*	*Description*
11	Fibric sphagnum	Sphagnum organic material in a fibric degree of decomposition in which the fibric materials are readily identifiable as to botanical origin; peat is usually undecomposed (or fibric), light yellowish brown to pale brown, and loose and spongy in consistence with the entire sphagnum plant being readily identifiable
21	Mesic sedge	Sedge organic material in a mesic (or intermediate) degree of decomposition; peat composed dominantly of sedge (*Carex* spp.) and generally moderately decomposed and matted; the sedge leaves are readily identifiable to the naked eye; this material commonly contains large amounts of very fine roots of the above species
22	Mesic woody sedge	Woody sedge organic material in a mesic (or intermediate) degree of decomposition; peat is composed dominantly of sedge peat (see code 21) with subdominant amounts of woody materials

23	Mesic woody forest	Woody forest organic material in a mesic (or intermediate) degree of decomposition; peat is composed dominantly (>50%) of woody materials derived from both coniferous and deciduous tree species; in general, wood fragments are easily identifiable in this peat
25	Mesic sphagnum	Sphagnum organic material in a mesic (or intermediate) degree of decomposition
31	Humic sedge	Sedge organic material in a humic (or most advanced) degree of decomposition in which most of the material is humified, and there are few recognizable fibers
#	Non applicable	(Urban area).

10 Parent material texture (Cols. 23–26)

(*Refs.* Research Branch, Agriculture Canada 1976; Expert Committee on Soil Survey 1982)

Soil texture indicates the relative proportions of the various soil separates in a soil as described by the classes of texture shown in Fig. 11.

Soil separates are mineral particles, <2.0 mm in equivalent diameter, ranging between specified size limits:

Soil separate	*Diameter (mm)*
Very coarse sand	2.0–1.0
Coarse sand	1.0–0.50
Medium sand	0.50–0.25
Fine sand	0.25–0.10
Very fine sand	0.10–0.05
Silt	0.05–0.002
Clay	<0.002

Coarse fragments are rock or mineral fragments >2.0 mm in diameter:

Coarse fragment	*Diameter (cm)*
Gravel	0.2–7.5
Cobble	7.5–25.0

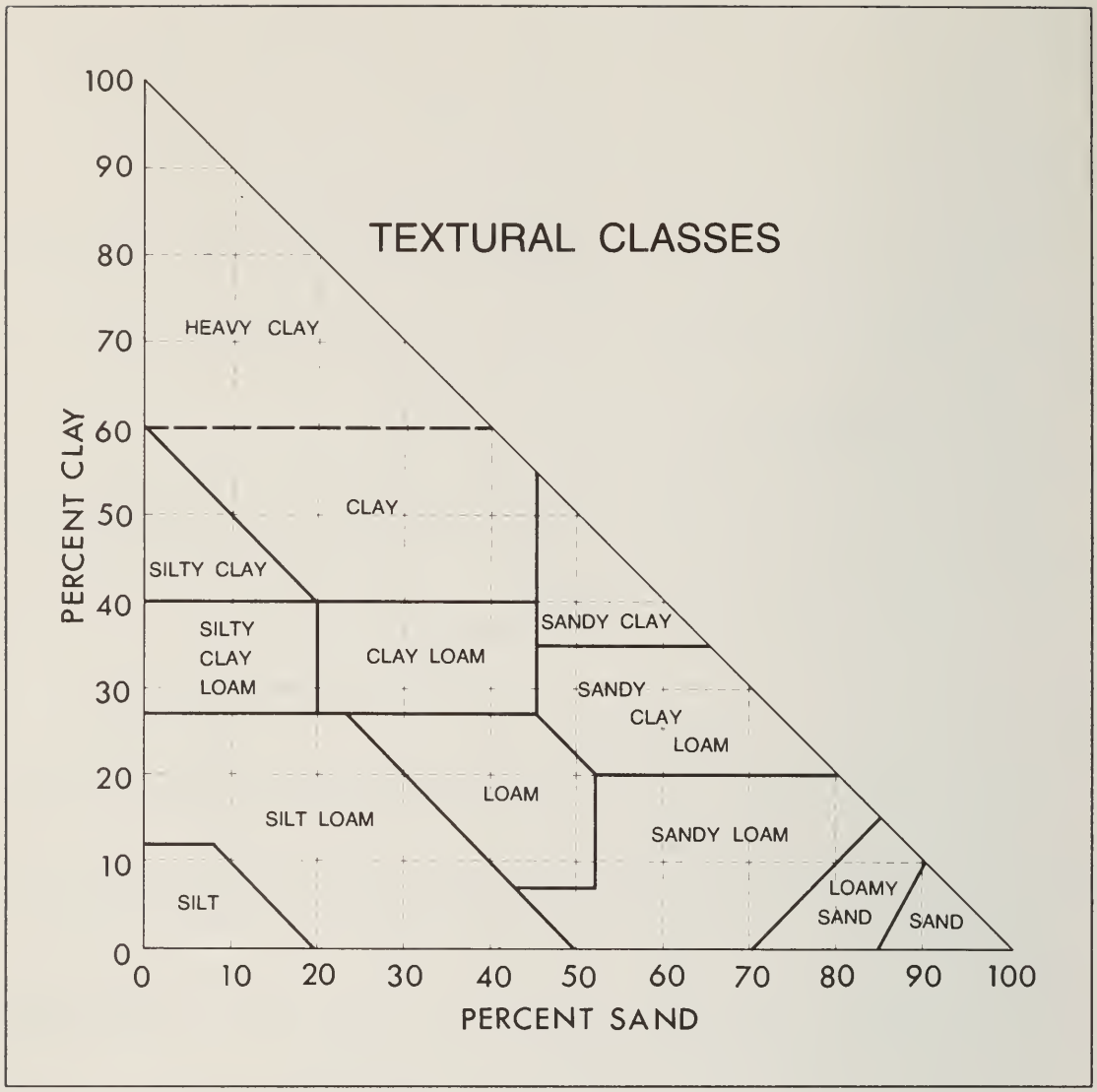


Fig. 11 Soil textural classes.

Enter the code for one texture per soil landscape:

Code	*Class*	*Description*
CBS	Cobbly sand	15–35% cobbles by volume
VGS	Very gravelly sand	35–60% gravel by volume
GS	Gravelly sand	15–35% gravel by volume
S	Sand	See Fig. 11
CS	Coarse sand	25% or more very coarse and coarse sand
FS	Fine sand	50% or more fine sand
VS	Very fine sand	50% or more very fine sand
LFS	Loamy fine sand	50% or more fine sand
LVFS	Loamy very fine sand	50% or more very fine sand
CBLS	Cobbly loamy sand	15–35% cobbles by volume
VGLS	Very gravelly loamy sand	35–60% gravel by volume

GLS	Gravelly loamy sand	15–35% gravel by volume
LS	Loamy sand	See Fig. 11
CBSL	Cobbly sandy loam	15–35% cobbles by volume
VGSL	Very gravelly sandy loam	35–60% gravel by volume
GSL	Gravelly sandy loam	15–35% gravel by volume
SL	Sandy loam	See Fig. 11
GFL	Gravelly fine sandy loam	15–35% gravel by volume
FL	Fine sandy loam	30% or more fine sand
CBL	Cobbly loam	15–35% cobbles by volume
GL	Gravelly loam	15–35% gravel by volume
L	Loam	See Fig. 11
VL	Very fine sandy loam	30% or more very fine sand
GSIL	Gravelly silt loam	15–35% gravel by volume
SIL	Silt loam	See Fig. 11
GSCL	Gravelly sandy clay loam	15–35% gravel by volume
SCL	Sandy clay loam	See Fig. 11
VCL	Very fine sandy clay loam	30% or more very fine sand
CBCL	Cobbly clay loam	15–35% cobbles by volume
GCL	Gravelly clay loam	15–35% gravel by volume
CL	Clay loam	See Fig. 11
SICL	Silty clay loam	See Fig. 11
SC	Sandy clay	See Fig. 11
C	Clay	See Fig. 11
GSIC	Gravelly silty clay	15–35% gravel by volume
SIC	Silty clay	See Fig. 11
HC	Heavy clay	See Fig. 11
#	Non applicable.	

11 Soil development (Col. 27)

(*Ref*. Agriculture Canada Expert Committee on Soil Survey 1987)

Enter the code:

Code	*Class*	*Description*
A	Brown Chernozemic	Dominantly Orthic Brown subgroup with inclusions of other subgroups within the Brown great group
B	Dark Brown Chernozemic	Dominantly Orthic Dark Brown subgroup with inclusions of other subgroups within the Dark Brown great group
C	Black Chernozemic	Dominantly Orthic Black subgroup with inclusions of other subgroups within the Black great group

D	Dark Gray Chernozemic or Dark Gray Luvisolic	Dominantly Orthic Dark Gray Chernozemic subgroup or Dark Gray Luvisol subgroup with inclusions of other subgroups within the Dark Gray great group or of the gleyed Dark Gray Luvisol subgroup
E	Gray Brown Luvisolic	Dominantly Orthic Gray Brown Luvisol subgroup with inclusions of other subgroups within the Gray Brown Luvisol great group
F	Gray Luvisolic	Dominantly Orthic Gray Luvisol subgroup with inclusions of other Gray Luvisol subgroups
G	Brown Solonetzic	May be dominantly Brown Solonetz or Brown Solodized Solonetz or Brown Solod subgroup with inclusions of these subgroups, i.e., dominantly Brown Solodized Solonetz with inclusions of Brown Solod
H	Dark Brown Solonetzic	May be dominantly Dark Brown Solonetz or Dark Brown Solodized Solonetz or Dark Brown Solod subgroup with inclusions of these subgroups
I	Brunisolic Gray Luvisolic	Dominantly Brunisolic Gray Luvisol subgroup with inclusions of its gleyed subgroup
J	Black Solonetzic	May be dominantly Black Solonetz or Black Solodized Solonetz or Black Solod subgroup with inclusions of these subgroups and their gleyed subgroups
K	Gray Solonetzic	Dominantly Gray Solodized Solonetz or Gray Solod subgroups with inclusions of their gleyed subgroups
L	Melanic Brunisolic	Dominantly Melanic Brunisol great group
M	Eutric Brunisolic	Dominantly Eutric Brunisol great group
N	Sombric Brunisolic	Dominantly Sombric Brunisol great group
O	Organic Cryosolic	Dominantly Organic Cryosol great group
P	Dystric Brunisolic	Dominantly Dystric Brunisol great group
Q	Humic Podzolic	Dominantly Humic Podzol great group
R	Regosolic	Dominantly Regosolic order

S	Static Cryosolic	Dominantly Static Cryosol great group
T	Turbic Cryosolic	Dominantly Turbic Cryosol great group
U	Gleysolic	Dominantly Gleysolic order
V	Ferro-Humic Podzolic	Dominantly Ferro-Humic Podzol great group
W	Humo-Ferric Podzolic	Dominantly Humo-Ferric Podzol great group
X	Fibrisol	Dominantly Fibrisol great group
Y	Mesisol	Dominantly Mesisol great group
Z	Humisol	Dominantly Humisol great group
2	Folisol	Dominantly Folisol great group
3	Podzolic Gray Luvisolic	Podzolic Gray Luvisol subgroup; only occurs as subdominant
#	Non applicable.	(Water, rock, or ice).

12 Surface texture of mineral soil to 15 cm (Cols. 28–31)

(*Refs.* Research Branch, Agriculture Canada 1976; Expert Committee on Soil Survey 1982)

Enter the code for one texture per soil landscape using same codes as for attribute number 10, *Parent material texture*.

13 Coarse fragment content in control section of mineral soils (Col. 32)

(*Ref.* Expert Committee on Soil Survey 1982)

Enter the code:

Code	*Class*	*Description*
A	<10% by volume	Rounded, subrounded, flat, angular or irregular rock fragment from 0.2 to 60 cm or more in size
B	10–30%	
C	31–65%	
D	>65%	
#	Non applicable.	

14 Rooting depth, unrestricted (Cols. 33–35)

(*Source*: consensus decision, rather subjective)

Enter the code:

Code	*Class*
0	<20 cm
50	20–75 cm
100	76–150 cm
200	>150 cm
#	Non applicable (e.g., rock, ice).

15 Kind of compacted, consolidated, or contrasting layer (Col. 36)

(*Refs.* Research Branch, Agriculture Canada 1976; Expert Committee on Soil Survey 1982; United States Department of Agriculture 1986; Agriculture Canada Expert Committee on Soil Survey 1987)

Enter the code:

Code	*Class*	*Description*
A	Compacted parent material	Compacted glacial till or other material
B	Basal till	Compacted glacial till deposited beneath a moving glacier
C	Compacted material (anthropogenic)	Soil material compacted by human activities that adversely affect crop production
D	Duric horizon	This strongly cemented Bc horizon does not satisfy the criteria of a podzolic B horizon; usually it has an abrupt upper boundary to an overlying podzolic B or to a Bm horizon and a diffuse lower boundary >0.5 m below; cementation is usually strongest near the upper boundary and occurs commonly at a depth of 40–80 cm from the mineral surface; the color of the duric horizon usually differs little from that of the moderately coarse textured to coarse textured parent material, and the structure is usually massive or very coarse platy; air-dry clods of duric horizons do not slake when immersed in water, and moist clods $\geq$3 cm thick usually cannot be broken in the hands
F	Fragipan	Horizon of fragipan character; a fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content; when

		dry, it has a hard consistence and seems to be cemented; when moist, it has moderate to weak brittleness; it commonly has bleached fracture planes and is overlain by a friable B horizon; air-dry clods of fragic horizons slake in water
O	Ortstein	This strongly cemented Bh, Bhf, or Bf horizon, ≥3 cm thick, occurs in more than one-third of the exposed face of the pedon; ortstein horizons are generally reddish brown to very dark reddish brown
P	Placic horizon	This layer (commonly ≤5 mm thick) or series of thin layers is irregular or involuted, hard, impervious, commonly vitreous, and dark reddish brown to black; placic horizons may be cemented by Fe, Al-organic complexes (Bhfc or Bfc), hydrated Fe oxides (Bgfc), or a mixture of Fe and Mn oxides
R	Rock	Consolidated bedrock too hard either to break with the hands (>3 on Mohs' scale) or to dig when moist
G	Gravel	A layer of coarse fragments with diameters of 0.2–7.5 cm
L	Colluvium	See attribute number 09, code C
S	Sand	Soil texture class in which the material contains >85% of sand-sized separate; the percentage of silt plus 1.5 times the percentage of clay does not exceed 15%
X	Silt	Soil texture class in which the material contains ≥80% silt and <12% clay
Y	Clay	Soil texture class in which the material contains ≥40% clay, <45% sand, and <40% silt-sized separates.

16 Depth to compacted, consolidated, or contrasting layer (Col. 37)

(*Source*: consensus decision)

Enter the code:

Code	*Class*
1	0–49 cm
2	50–100 cm
3	>100 cm
4	<100 cm for mineral overlays
5	<160 cm for shallow (terric) organic
#	Non applicable.

17 Drainage class (Col. 38)

(*Refs.* Expert Committee on Soil Survey 1982; Agriculture Canada Expert Committee on Soil Survey 1987)

Enter the code:

Code	*Class*	*Description*
E	Excessive	Water is removed from the soil very rapidly in relation to supply; excess water flows downward very rapidly if underlying material is pervious; subsurface flow may be very rapid during heavy rainfall provided the gradient is steep; source of water is precipitation
R	Rapid	Water is removed from the soil rapidly in relation to supply; excess water flows downward if underlying material is pervious; subsurface flow may occur on steep gradients during heavy rainfall; source of water is precipitation
W	Well	Water is removed from the soil readily but not rapidly; excess water flows downward readily into underlying pervious material or laterally as subsurface flow; these soils commonly retain optimum amounts of moisture for plant growth after rains or addition of irrigation water
M	Moderately well	Water is removed from the soil somewhat slowly in relation to supply; excess water is removed somewhat slowly because of low perviousness, shallow water table, lack of gradient, or some combination of these; precipitation is the dominant source of water in

		medium-to-fine textured soils; precipitation and significant additions by subsurface flow are necessary in coarse-textured soils
I	Imperfect	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season; excess water moves slowly downward if precipitation is the major supply; if subsurface water or groundwater, or both, is the main source, the flow rate may vary but the soil remains wet for a significant part of the growing season
P	Poor	Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen; excess water is evident in the soil for much of the time; subsurface flow or groundwater flow, or both, in addition to precipitation are the main sources of water; there may also be a perched water table
V	Very poor	Water is removed from the soil so slowly that the water table remains at or on the surface for most of the time the soil is not frozen; groundwater flow and subsurface flow are the major sources of water; precipitation is less important except where there is a perched water table
#	Non applicable.	

18 Available water capacity in upper 120 cm (Col. 39)

(*Ref.* Research Branch, Agriculture Canada 1976; De Jong et al. 1984)

Enter the code:

Code	*Class*	*Description*
1	50 mm	That portion of water in a soil that can be readily absorbed by plant roots; most workers consider it to be the water held in the soil between field
2	100 mm	
3	150 mm	
4	200 mm	

5	250 mm	capacity and a pressure of up to about 15 bars
6	Non applicable	(Solonetzic or saline soils)
7	Non applicable	(High water table)
8	Non applicable	(Perennially frozen subsoils)
#	Non applicable	(Water, ice, rock).

19 Depth to water table, average (Col. 40)

(*Source*: concensus decision)

Enter the code:

Code	*Class*	*Description*
1	0–2 m	Most shallow water table during growing season
2	2–3 m	
3	>3 m	
4	0–1 m	
5	1–2 m	
6	0–1 m	With perennially frozen subsoil
#	Non applicable	(Water, ice, rock).

20 Ice type (Col. 41)

(*Source*: concensus decision)

Enter the code:

Code	*Class*
1	Ice crystals and ice lenses
2	Ice wedges
3	Massive ground ice
4	Undifferentiated
#	Non applicable.

21 Ice content (Col. 42)

(*Source*: concensus decision)

Enter the code:

Code	*Class*
L	Low
M	Medium
H	High
#	Non applicable.

22 Permafrost occurrence (Col. 43)

(*Refs.* Brown 1970, 1978)

Enter the code:

Code	*Class*	*Description*
V	Very sporadic	Sparse patches of permafrost occurring near the southern limit of permafrost
S	Sporadic	The occurrence of isolated patches or islands of permafrost near the southern boundary of discontinuous permafrost zone
D	Discontinuous	Permafrost occurring in some areas beneath the exposed land surface throughout a geographic region where other areas are free of permafrost
C	Continuous	Permafrost occurring everywhere beneath the exposed land surface throughout a geographic region with the exception of widely scattered sites, such as newly deposited unconsolidated sediments
#	Non applicable.	

23 Active layer depth in soils with permafrost (Cols. 44–46)

(*Ref.* Permafrost Subcommittee, Associate Committee on Geotechnical Research 1988)

Enter the number representing depth in centimetres:

Entry	*Class*	*Description*
Depth in cm	Average depth of active layer (cm)	Top layer of ground subject to annual thawing and freezing in areas underlain by permafrost
#	Non applicable.	

24 Kind of patterned ground in soils with permafrost (Cols. 47–48)

(*Refs.* Washburn 1980; National Wetlands Working Group 1987; Permafrost Subcommittee, Associate Committee on Geotechnical Research 1988)

Enter the code:

Code	*Class*	*Description*
01	Sorted circle	Patterned ground having a dominantly circular mesh and a sorted appearance commonly produced by a border of stones surrounding finer material
02	Sorted net	Patterned ground having a mesh neither dominantly circular nor polygonal; a sorted appearance results from borders of stones surrounding finer material
03	Sorted stripe	Patterned ground with a striped pattern and sorted appearance resulting from parallel lines of stones and intervening stripes of finer material oriented down the steepest available slope
04	Sorted large polygon	Patterned ground having a dominantly polygonal mesh and a sorted appearance commonly produced by border of stones surrounding finer material; polygon diameter is >1 m
05	Sorted small polygon	As for code 04 except that polygon diameter is <1 m
06	Nonsorted circle	Patterned ground having a dominantly circular mesh but lacking a border of stones
07	Nonsorted net	Patterned ground having neither a dominantly circular or polygonal mesh nor a border of stones
08	Nonsorted large polygon	Patterned ground having a dominantly polygonal mesh but lacking a border of stones; polygon diameter is >1 m
09	Nonsorted small polygon	As for code 08 except that polygon diameter is <1 m
10	Earth hummock	Hummock having a core of silty and clayey mineral soil and showing signs of cryoturbation
11	Lowland (peat) polygon	Bog with flat-topped or convex peat surfaces separated by trenches over ice wedges that form a polygonal pattern at the surface
12	Polygonal peat plateau	Generally flat-topped expanse of peat elevated above the general surface of a wetland and containing segregated

		ice that may or may not extend downward into underlying mineral soil
13	No pattern	Unpatterned ground
#	Non applicable.	

25 pH of upper 15 cm of soil measured in $CaCl_2$ (Cols. 49–50)

(*Ref.* Research Branch, Agriculture Canada 1976)

Enter pH value to one decimal in the two designated columns (e.g., a pH value of 6.7 is coded as 67).

Non applicable (water, rock, ice).

26 pH of upper 15 cm of soil measured in water (Cols. 51–52)

(*Ref.* Research Branch, Agriculture Canada 1976)

Enter pH value to one decimal in the two designated columns (e.g., a pH value of 6.7 is coded as 67).

Non applicable (water, rock, ice).

27 Organic carbon of upper 15 cm of soil (Cols. 53–54)

(*Ref.* Research Branch, Agriculture Canada 1976)

Enter nearest % value of organic carbon.

Non applicable (water, rock, ice).

28 Nitrogen content of upper 15 cm of soil (Col. 55)

(*Source*: concensus decision)

Enter the code:

Code	*Class*
0	<0.1%
1	0.1–0.5%
2	0.6–1.5%
3	>1.5%
#	Non applicable (water, rock, ice).

29 Thickness of humus layer (L,F,H) (Col. 56)

(*Source*: concensus decision)

Enter the code:

Code	*Class*
0	<5 cm
1	5–10 cm
2	11–20 cm
3	21–40 cm
4	>40 cm
#	Non applicable (e.g., cultivated, eroded).

30 Calcareous class of parent material (Col. 57)

(*Ref.* Agriculture Canada Expert Committee on Soil Survey 1987)

Enter the code:

Code	*Class*	*Description*
0	Non calcareous	No $CaCO_3$ detectable with dilute HCl
1	Weakly	1–5% $CaCO_3$ equivalents (weak effervesence with dilute HCl)
2	Strongly	6–40% $CaCO_3$ equivalents (moderate to strong effervescence with dilute HCl)
3	Extremely	>40% $CaCO_3$ equivalents (very strong effervescence with dilute HCl)
#	Non applicable	(Water, rock, ice).

31 Inclusions 1 (Cols. 58–59)

(*Refs.* Research Branch, Agriculture Canada 1976; Expert Committee on Soil Survey 1982; Agriculture Canada Expert Committee on Soil Survey 1987)

NOTE: Inclusions may represent a maximum of 15% of the polygon area. Although their percent occupance is relatively small, they are generally strongly contrasting to the dominant or subdominant soil landscapes. A maximum of two inclusions may be recorded for each of the dominant and subdominant soil landscapes; a maximum of four inclusions may be recorded for each polygon. Inclusions provide an opportunity to document that "little bit" of extra information about the polygon. They may be associated with the dominant or subdominant soil landscape or they may occur independently. Extreme caution is recommended when using inclusion information in area calculations.

Enter the code:

Code	*Class*	*Description*
A	Acid surface soil	pH <6.0
BG	Bog	See attribute number 09, code B
BL	Black Chernozemic soil	See attribute number 11, code C
BC	Brown Chernozemic soil	See attribute number 11, code A

BR	Bedrock, hard	Consolidated bedrock that is too hard either to break with the hands (>3 on Mohs' scale) or to dig with a spade when moist
BS	Bedrock, soft	Bedrock that can be broken with the hands (<3 on Mohs' scale) and dug with a spade when moist
C	Clay substrate	Clay material forming a lithologic discontinuity within 1 m of the soil surface
CA	Calcareous surface soil	Indicated by visible effervescence when dilute HCl is added
CC	Colluvium	See attribute number 09, code C
CH	Chernozemic soil	Unspecified Chernozemic soils; more than one subgroup present
CY	Clay	See attribute number 10
D	Dissected surface form	See attribute number 07, code D
DB	Dark Brown Chernozemic soil	See attribute number 11, code B
DC	Deep colluvium	Colluvial material (see attribute number 09, code C) to a depth of >1 m
DG	Deep gravelly fluvioglacial material	Gravelly fluvioglacial material to a depth of >1 m; see attribute numbers 09 (code F) and 10
DU	Duric material	See attribute number 15, code D
E	Eroded knolls	Relatively light-colored knolls compared to other slope positions, occurring in hummocky or knoll-and-kettle surface forms
EO	Eolian material	>50 cm of eolian material (see attribute number 09, code E)
ES	Eroded slopes	Slopes eroded by water
F	Fluvioglacial substrate	Substrate of fluvioglacial material (see attribute number 09, code F)
FH	Ferro-Humic Podzolic soil	See attribute number 11, code V
FO	Folisol	See attribute number 11, code 2
G	Sandy loam morainal material	Morainal material with a sandy loam texture (see attribute number 10)
GF	Gravelly alluvium	See attribute numbers 09 (code A) and 10
GG	Gravelly fluvioglacial material	See attribute numbers 09 (code F) and 10
GL	Gleyed soil	Presence of faint to distinct mottles

		(or blotches) of different color interspersed within the dominant matrix color
GM	Gravelly marine material	See attribute numbers 09 (code W) and 10
GV	Orthic Gray Luvisolic soil	See attribute number 11, code F
GY	Gleysolic soil	See attribute number 11, code U
HC	Shallow lithic colluvium	Colluvial material (see attribute number 09, code C) overlying a lithic contact 50–100 cm from the surface
HP	Humo-Ferric Podzolic soil	See attribute number 11, code W
HU	Hummocky surface form	See attribute number 07, code H
I	Brunisolic Gray Luvisolic soil	See attribute number 11, code I
IC	Ice	See attribute number 03, code IC
ID	Imperfectly drained soil	See attribute number 17, code I
L	Melanic Brunisolic soil	See attribute number 11, code L
LC	Lacustrine material	See attribute number 09, code L
LF	Loamy alluvium material	See attribute numbers 09 (code A) and 10
LI	Lithic layer	Bedrock occurring within the normal depth of soil development, usually within 1 m of the soil surface
LM	Loamy morainal till	Till (or morainal) material in which soil separates contain <35% clay and coarse fragments occupy <35% by volume
LO	Loamy marine material	See attribute numbers 09 (code W) and 10
LS	Silty lacustrine material	See attribute numbers 09 (code L) and 10
LU	Luvisolic soil	See attribute number 11, code E or F
M	Eutric Brunisolic soil	See attribute number 11, code M
ML	Clay loam marine material	See attribute numbers 09 (code W) and 10
MP	Moss peat	Relatively undecomposed, spongy organic material
N	Sombric Brunisolic soil	See attribute number 11, code N
NN	None	
O	Organic material	See attribute number 09, code O

OC	Organic Cryosolic soil	See attribute number 11, code O
OT	Ortstein	See attribute number 15, code O
P	Dystric Brunisolic soil	See attribute number 11, code P
PD	Poorly drained soil	See attribute number 17, code P
PP	Poorly drained, peaty soil	Poorly drained soil with a peaty surface layer (<40 cm thick)
R1	Soft rock outcrops	See attribute number 03, code R1
R2	Hard rock outcrops, acidic	Granite rock outcrops
R3	Hard rock outcrops, basic	Limestone rock outcrops
R4	Hard rock outcrops, undifferentiated	See attribute number 03, code R4
RD	Rapidly drained soil	See attribute number 17, code R
RG	Regosolic soil	See attribute number 11, code R
SA	Saline soil	Soil causing an obvious reduction in crop growth, may have white surface crust
SC	Static Cryosolic soil	See attribute number 11, code S
SD	Sandy marine material	Marine material with a sand texture class; see attribute numbers 09 (code W) and 10
SF	Sandy alluvium	See attribute numbers 09 (code A) and 10
SG	Sandy fluvioglacial material	Fluvioglacial material but with a sand texture class; see attribute numbers 09 (code F) and 10
SH	Gravelly shoreline	See attribute number 10
SL	Silty alluvium	See attribute numbers 09 (code A) and 10
SO	Sombric Humo-Ferric Podzolic soil	See attribute number 11, code W
SP	Steep surface form	See attribute number 07, code S
SS	Silty surface texture	See attribute number 10
ST	Stoney surface	Sufficient stones to seriously handicap cultivation
SY	Sandy material	See attribute number 10
T	Till substrate	Till (or morainal) material forming a lithologic discontinuity within 1 m of the soil surface
TA	Talus	Sloping mass of rock fragments below a cliff or at the foot of a steep slope
TC	Turbic Cryosolic soil	See attribute number 11, code T

TE	Terric layer	Unconsolidated mineral substratum occurring within the normal depth of organic soil development (40–160 cm)
TR	Terraced surface form	See attribute number 07, code T
TT	Anthropogenic material	See attribute number 09, code T
VA	Volcanic ash	Deposition of fine, wind-transported material of volcanic origin deposited in thin layers that persist for a long time in bogs, river terraces, talus slopes, and kettle holes
VS	Very shallow lithic layer	Rock material occurring at <50 cm from the surface
WD	Well-drained soil	See attribute number 17, code W
WE	Wind erosion	Removal of surface soil particles caused by wind action
WT	Wetlands	Lands dominated by the persistent presence of excess water indicated by Gleysolic and shallow Organic soils under a cover of hydrophytic vegetation
X	Fibrisol	See attribute number 11, code X
Y	Mesisol	See attribute number 11, code Y
Z	Humisol	See attribute number 11, code Z
11	Fibric-sphagnum soil	Sphagnum organic soil in the stage of decomposition in which fibric materials are readily identifiable as to botanical origin
14	Patterned ground	See attribute number 24
17	Bouldery material	Rounded or irregular coarse fragments >60 cm in diameter
21	Mesic-sedge material	Sedge organic material in a mesic (or intermediate) degree of decomposition
23	Mesic-woody forest material	Woody-forest organic material in a mesic degree of decomposition; the material is partly altered physically and biochemically
#	Non applicable.	

32 Inclusions 2 (Cols. 60–61)

(See attribute number 31 for codes, classes, and descriptions)

33 Vegetative cover or landuse, or both (Cols. 62–63)

(*Refs.* National Wetlands Working Group 1987; Permafrost Subcommittee, Associate Committee on Geotechnical Research 1988)

Enter the code:

Code	*Class*	*Description*
A	Agricultural crops	Annual field crops
B	Bog	Bogs may be treed or treeless and are usually covered with *Sphagnum* spp. and ericaceous shrubs
C	Coniferous forest	Dominated by needle-leaved, cone-bearing species
D	Deciduous forest	Dominated by broadleaf species
F	Fen	Dominated by sedges, grasses, reeds, and brown mosses with some shrubs and, at times, a sparse tree layer
G	Grassland	Perennial native grassland or improved pasture
H	Arctic desert	Unvegetated areas in the polar desert of the high Arctic; may be caused by either climatic (too cold or too dry) or edaphic (low soil nutrients or toxic substrate) factors, or a combination of both
M	Mixed deciduous and coniferous forest	See codes C and D
P	Parkland	A forest–grassland transition comprising a mozaic of trembling aspen stands interspersed with patches of cropland, grassland, and meadow
R	Marshland	A mozaic surface pattern composed of pools or channels interspersed with clumps of emergent sedges, grasses, rushes, and reeds, bordering grassy meadows and peripheral bands of shrubs or trees; submerged and floating aquatics flourish in open water areas
S	Shrubland	Dominated by shrub species
SP	Sedge peat	Dominated by *Carex* spp. and generally moderately decomposed and matted; the sedge leaves are readily identifiable to the naked eye
TA	Tundra, alpine	Treeless terrain found at high altitudes occurring immediately above the forest zone and the upper altitudinal timberline; tundra vegetation comprises lichens,

		mosses, sedges, grasses, forbs, and low shrubs (≤20 cm) including heaths, dwarf willows, and birches
TL	Tundra, low shrub	Treeless terrain found at high latitudes occurring most widely in the zone immediately north of the boreal forest including the treeless parts of the forest–tundra ecotone adjacent to the treeline; tundra vegetation comprises lichens, mosses, sedges, grasses, forbs and low shrubs (≤20 cm) including heaths, dwarf willows, and birches
TM	Tundra, medium shrub	Similar to low-shrub tundra (see code TL) except for medium (>20 cm) instead of low shrubs
U	Unvegetated surface	
#	Non applicable.	

34 Lake size estimated from LANDSAT imagery (Col. 64)

(*Source*: concensus decision)

Enter the code:

Code	*Class*	*Description*
S	Small	<1 km^2 (not visible on 1:1 million scale LANDSAT imagery)
M	Medium	1–10 km^2
L	Large	11–50 km^2
V	Very large	>50 km^2
#	Non applicable.	

35 Water bodies estimated from LANDSAT imagery, which are wholly contained within the polygon, in percentage coverage of entire polygon (Col. 65)

(*Source*: concensus decision)

Enter the code:

Code	*Class*	*Description*
F	Few	Water-bodies cover 0–10% area of polygon
C	Common	Water-bodies cover 11–25% area of polygon
M	Many	Water-bodies cover 26–50% area of polygon

A	Abundant	Water-bodies cover >50% area of polygon
#	Non applicable.	

NOTE: Lakes and water bodies whose shorelines form polygon boundaries are not included.

36 Reliability class of polygon (Col. 66)

(*Source*: consensus decision)

Reliability of generalized maps is required to provide an indication of the confidence that can be placed in derivative interpretations and to assist in assigning priorities for future field-mapping projects. Four levels of map reliability have been established in relation to inspection intensity and publication scale of source documents and whether aerial photographs are used during field mapping.

Enter the code:

Code	*Class*	*Description*
V	Very low	Compiled from interpretation of LANDSAT data *only*; no ground data are collected for verification of these areas
L	Low	Compiled from soil survey maps produced from field traverses at wide intervals (up to 10 km) and without the use of aerial photographs *or* Compiled from maps produced by inspections using fixed-wing aircraft or helicopter and aided by interpretation of LANDSAT imagery
M	Medium	Produced from systematic traverses by helicopter and by interpretation of stereoscopic aerial photographs *or* Compiled from modern soil survey procedures, which include traversing existing accessible roads in wilderness areas, and aided by interpretation of stereoscopic aerial photographs
H	High	Compiled from modern soil survey maps produced from field traverses at ≤1.6-km intervals and with the aid of stereoscopic aerial photographs.

37 Complexity class of polygon (Col. 67)

(*Source*: consensus decision)

Complexity of soil landscape attribute classes is determined from information provided on source maps and the accompanying soil reports. The concept of complexity provides an indication of attribute variability within a polygon, particularly with respect to the classes of parent material deposition modes and soil development. Three levels of complexity have been established. They provide a warning of variability to anyone interpreting the information.

Enter the code:

Code	*Class*	*Description*
L	Low	Soil and landscape attributes within the polygon are uniform for most interpretations; in most cases the polygon has only a dominant component
M	Medium	Soil and landscape attributes are moderately variable but predictable; there are generally dominant and subdominant components, each of which usually have been generalized from no more than two classes of parent material or soil development, or both; there may also be an inclusion in the polygon
H	High	Soil and landscape attributes are highly variable and unpredictable; dominant, subdominant, and inclusion components are present, each of which has been generalized from more than two classes of parent material or soil development, or both; use this class to warn of extreme oversimplification in any interpretations from the extended legend.

38 Soil name 1 (Cols. 68–73)

(*Source*: consensus decision)

Provision has been made for a maximum of two soil name codes each for the dominant and subdominant soils. Soil name 1 is considered to be most representative of each soil landscape. Soil name 2 may be used to signify a codominant combination of two soils or an important, closely associated soil in the landscape.

Caution is recommended when using soil name 2 in area calculations particularly for subdominant landscapes.

Soil name codes (and modifiers when present) are included in this detailed legend to provide a link to the national CanSIS soil names and soil layer files. Data in the soil layer file is required for agricultural and nonagricultural use interpretations, simulation modeling, and general land evaluation studies.

Enter the soil name code (and modifier when present) as found in the soil names file maintained at the local soil survey office. This code indicates the most representative soil in the dominant or subdominant soil landscape. The soil name code and modifier are consistent with those documented in the national CanSIS soil name and soil layer files. For areas where no soil name is established, use # for non applicable.

39 Soil name 2 (Cols. 74–79)

(*Source*: consensus decision)

Enter the soil name code (and modifier when present) as found in the soil names file maintained at the local soil survey office. This soil code may be used to signify a codominant combination of two soils or an important, closely associated soil. The soil name code and modifier are consistent with those documented in the national CanSIS soil name and soil layer files (see attribute number 38). For areas where no soil name is established, use # for non applicable.

NOTE: Caution is recommended when using soil name 2 in area calculations particularly for subdominant landscapes.

40 Parent material textural group as shown in the map symbol (Cols. 80–81)

(*Ref.* Shields 1982)

Enter the code:

Code	*Class*	*Description*[1]
sd	Sand	Group includes: CBS, CBLS, CS, S, LS, LFS, FS, GS, VGS, LVFS, VS, GLS, VGLS
sl	Sandy loam	Group includes: CBSL, SL, FL, GSL, VGSL, GFL
lm	Loam	Group includes: GL, CBL, L, GSIL, VL, SIL

[1] See attribute number 10 for textural class descriptions.

cl	Clay loam	Group includes: CBCL, GSCL, GCL, SCL, VCL, CL, SICL
cy	Clay	Group includes: SC, GSIC, SIC, C, HC.

41 Area of polygon (kilohectares) (Cols. 82–88)

Enter the number of kilohectares to one decimal place.

Summary of soil landscape attribute codes and their classes occurring in the dominant and subdominant files

01 Provincial code and map sheet number

Provincial code	*Map name*	*Sheet number*
BC	British Columbia—South	1
	—North	2
AL	Alberta	1
SK	Saskatchewan	1
MN	Manitoba	1
ON	Ontario—South	1
	—North	2
QU	Quebec—Southwest	1
	—Southeast	2
	—Central	3
	—North	4
NB	New Brunswick[1]	1
NS	Nova Scotia[1]	1
PE	Prince Edward Island[1]	1
NF	Newfoundland—South	1
	—North	2
YU	Yukon	1
NW	Northwest Territories	1 to 9.

02 Polygon number

03 Kind of rock outcrop or other material at the surface

IC	Ice and snow	R4	Hard rock, undifferentiated
OR	Organic soil	SO	Mineral soil
R1	Soft rock, undifferentiated	WA	Water
R2	Hard rock, acidic	UR	Urban
R3	Hard rock, carbonaceous		

[1] For map, see *Soil landscapes of Canada, Maritime Provinces*; for extended legend see *Soil landscapes of Canada: Maritimes*.

04 Percentage distribution of dominant and subdominant soil landscapes

05 Grid code for locating polygons

06 Regional landform

B	Tableland (or plateau) dominated	O	Organic wetland dominated
H	Hilland dominated	P	Plain dominated
M	Mountain dominated	S	Scarp dominated
		V	Valley dominated

07 Local surface form

Mineral surface forms

D	Dissected	M	Rolling
H	Hummocky (or irregular)	R	Ridged
I	Inclined	S	Steep
K	Knoll and kettle	T	Terraced
L	Level	U	Undulating

Wetland surface forms

B04	Domed bog	F01	Northern ribbed fen
B05	Polygonal peat plateau bog	F07	Shore fen
B07	Peat plateau bog	F11	Slope fen
B09	Atlantic plateau bog	F13	Horizontal fen
B13	Basin bog	S01	Stream swamp
B14	Flat bog	S04	Basin swamp
B15	String bog	M06	Stream marsh
B16	Blanket bog	M11	Shallow basin marsh
B18	Slope bog	M14	Shore marsh
B19	Veneer bog		

08 Slope gradient class

A	1–3%	D	16–30%
B	4–9%	E	31–60%
C	10–15%	F	>60%

09 Soil parent material mode of deposition (or origin)

Mineral materials and undifferentiated or unspecified organic materials

A	Alluvial	N	Fen (organic, unspecified)
B	Bog (organic, unspecified)	O	Organic, undifferentiated

C	Colluvial	R	Rock
D	Residual	S	Swamp (organic, unspecified)
E	Eolian	T	Anthropogenic
F	Fluvioglacial	U	Undifferentiated (mineral)
H	Marsh	V	Volcanic
L	Lacustrine	W	Marine
M	Morainal		

Specified organic materials

11	Fibric sphagnum	23	Mesic woody forest
21	Mesic sedge	25	Mesic sphagnum
22	Mesic woody sedge	31	Humic sedge

10 Parent material texture

CBS	Cobbly sand	CBL	Cobbly loam
VGS	Very gravelly sand	GL	Gravelly loam
GS	Gravelly sand	L	Loam
S	Sand	VL	Very fine sandy loam
CS	Coarse sand	GSIL	Gravelly silt loam
FS	Fine sand	SIL	Silt loam
VS	Very fine sand	GSCL	Gravelly sandy clay loam
LFS	Loamy fine sand	SCL	Sandy clay loam
LVFS	Loamy very fine sand	VCL	Very fine sandy clay loam
CBLS	Cobbly loamy sand	CBCL	Cobbly clay loam
VGLS	Very gravelly loamy sand	GCL	Gravelly clay loam
GLS	Gravelly loamy sand	CL	Clay loam
LS	Loamy sand	SICL	Silty clay loam
CBSL	Cobbly sandy loam	SC	Sandy clay
VGSL	Very gravelly sandy loam	C	Clay
GSL	Gravelly sandy loam	GSIC	Gravelly silty clay
SL	Sandy loam	SIC	Silty clay
GFL	Gravelly fine sandy loam	HC	Heavy clay
FL	Fine sandy loam		

11 Soil development

A	Brown Chernozemic	O	Organic Cryosolic
B	Dark Brown Chernozemic	P	Dystric Brunisolic
C	Black Chernozemic	Q	Humic Podzolic
D	Dark Gray Chernozemic or Dark Gray Luvisolic	R	Regosolic
		S	Static Cryosolic
E	Gray Brown Luvisolic	T	Turbic Cryosolic
F	Gray Luvisolic	U	Gleysolic
G	Brown Solonetzic	V	Ferro-Humic Podzolic
H	Dark Brown Solonetzic	W	Humo-Ferric Podzolic
I	Brunisolic Gray Luvisolic	X	Fibrisol
J	Black Solonetzic	Y	Mesisol

K	Gray Solonetzic	Z	Humisol
L	Melanic Brunisolic	2	Folisol
M	Eutric Brunisolic	3	Podzolic Gray Luvisolic
N	Sombric Brunisolic		

12 Surface texture of mineral soil to 15 cm

(See Parent material texture in attribute number 10)

13 Coarse fragment content in control section of mineral soils

A	<10% by volume	C	31–65%
B	10–30%	D	>65%

14 Rooting depth, unrestricted

0	<20 cm	100	76–150 cm
50	20–75 cm	200	>150 cm

15 Kind of compacted, consolidated, or contrasting layer

A	Compacted parent material	P	Placic horizon
B	Basal till	R	Rock
C	Compacted material (anthropogenic)	G	Gravel
		L	Colluvium
D	Duric horizon	S	Sand
F	Fragipan	X	Silt
O	Ortstein	Y	Clay

16 Depth to compacted, consolidated, or contrasting layer

1	0–49 cm	4	<100 cm for mineral overlays
2	50–100 cm		
3	>100 cm	5	<160 cm for shallow (terric) organic overlays

17 Drainage class

E	Excessive	I	Imperfect
R	Rapid	P	Poor
W	Well	V	Very poor
M	Moderately well		

18 Available water capacity in upper 120 cm

1	50 mm
2	100 mm

3	150 mm
4	200 mm
5	250 mm
6	Non applicable because of Solonetzic or saline soils
7	Non applicable because of high water table
8	Non applicable because of perennially frozen subsoils

19 Depth to water table, average

1	0–2 m	4	0–1 m
2	2–3 m	5	1–2 m
3	>3 m	6	0–1 m, frozen subsoil

20 Ice type

1	Ice crystals and ice lenses	3	Massive ground ice
2	Ice wedges	4	Undifferentiated

21 Ice content

L	Low
M	Medium
H	High

22 Permafrost occurrence

V	Very sporadic	D	Discontinuous
S	Sporadic	C	Continuous

23 Active layer depth in soils with permafrost (cm)

24 Kind of patterned ground in soils with permafrost

01	Sorted circle	08	Nonsorted large polygon
02	Sorted net	09	Nonsorted small polygon
03	Sorted stripe	10	Earth hummock
04	Sorted large polygon	11	Lowland (peat) polygon
05	Sorted small polygon	12	Polygonal peat plateau
06	Nonsorted circle	13	No pattern
07	Nonsorted net		

25 pH of upper 15 cm of soil measured in $CaCl_2$ (to one decimal)

26 pH of upper 15 cm of soil measured in water (to one decimal)

27 Organic carbon of upper 15 cm of soil (nearest % value)

28 Nitrogen content of upper 15 cm of soil

0	<0.1%	2	0.6–1.5%
1	0.1–0.5%	3	>1.5%

29 Thickness of humus layer (L,F,H)

0	<5 cm	3	21–40 cm
1	5–10 cm	4	>40 cm
2	11–20 cm		

30 Calcareous class of parent material

0	Non calcareous	2	Strongly
1	Weakly	3	Extremely

31 Inclusions 1

A	Acid surface soil
BG	Bog
BL	Black Chernozemic soil
BC	Brown Chernozemic soil
BR	Bedrock, hard
BS	Bedrock, soft
C	Clay substrate
CA	Calcareous surface soil
CC	Colluvium
CH	Chernozemic soil
CY	Clay
D	Dissected surface form
DB	Dark Brown Chernozemic soil
DC	Deep colluvium
DG	Deep gravelly alluvium material
DU	Duric material
E	Eroded knolls
EO	Eolian material
ES	Eroded slopes
F	Fluvioglacial substrate
FH	Ferro-Humic Podzolic soil
FO	Folisol
G	Sandy loam morainal material
GF	Gravelly alluvium
GG	Gravelly fluvioglacial material
GL	Gleyed soil
GM	Gravelly marine material
GV	Orthic Gray Luvisolic soil

GY Gleysolic soil
HC Shallow lithic colluvium
HP Humo-Ferric Podzolic soil
HU Hummocky surface form
I Brunisolic Gray Luvisolic soil
IC Ice
ID Imperfectly drained soil
L Melanic Brunisolic soil
LC Lacustrine material
LF Loamy alluvium material
LI Lithic layer
LM Loamy morainal till
LO Loamy marine material
LS Silty lacustrine material
LU Luvisolic soil
M Eutric Brunisolic soil
ML Clay loam marine material
MP Moss peat
N Sombric Brunisolic soil
NN None
O Organic material
OC Organic Cryosolic soil
OT Ortstein
P Dystric Brunisolic soil
PD Poorly drained soil
PP Poorly drained, peaty soil
R1 Soft rock outcrops
R2 Hard rock outcrops, acidic
R3 Hard rock outcrops, basic
R4 Hard rock outcrops, undifferentiated
RD Rapidly drained soil
RG Regosolic soil
SA Saline soil
SC Static Cryosolic soil
SD Sandy marine material
SF Sandy alluvium
SG Sandy fluvioglacial material
SH Gravelly shoreline
SL Silty alluvium
SO Sombric Humo-Ferric Podzolic soil
SP Steep surface form
SS Silty surface texture
ST Stoney surface
SY Sandy material
T Till substrate
TA Talus
TC Turbic Cryosolic soil
TE Terric layer
TR Terraced surface form

TT	Anthropogenic material
VA	Volcanic ash
VS	Very shallow lithic layer
WD	Well-drained soil
WE	Wind erosion
WT	Wetlands
X	Fibrisol
Y	Mesisol
Z	Humisol
11	Fibric-sphagnum soil
14	Patterned ground
17	Bouldery material
21	Mesic-sedge material
23	Mesic-woody forest material

32 Inclusions 2 (see attribute number 31 for codes)

33 Vegetative cover or landuse, or both

A	Agricultural crops	P	Parkland
B	Bog	R	Marshland
C	Coniferous forest	S	Shrubland
D	Deciduous forest	SP	Sedge peat
F	Fen	TA	Tundra, alpine
G	Grassland	TL	Tundra, low shrub
H	Arctic desert	TM	Tundra, medium shrub
M	Mixed deciduous and coniferous forest	U	Unvegetated surface

34 Lake size estimated from LANDSAT imagery

S	Small	L	Large
M	Medium	V	Very large

35 Water bodies estimated from LANDSAT imagery, which are wholly contained within the polygon

F	Few	M	Many
C	Common	A	Abundant

36 Reliability class of polygon

V	Very low	M	Medium
L	Low	H	High

37 Complexity class of polygon

L	Low
M	Medium
H	High

38 Soil name 1

39 Soil name 2

40 Parent material textural group (as shown in the map symbol)

sd	Sand	cl	Clay loam
sl	Sandy loam	cy	Clay
lm	Loam		

41 Area of polygon (kilohectares)

Maps in digital form

This section defines the minimum and complete content of digital soil map data for maps in the *Soil landscapes of Canada* series. For a general description of CanSIS and the data organization and manipulation capabilities please refer to *CanSIS manual I: General description* (MacDonald and Valentine in preparation).

CanSIS is a soil geographical information system (GIS) developed and supported by LRRC. Amongst other activities, CanSIS personnel develop and manage the national soil data base (NSDB), which contains the location, nature, and attributes related to the biological productivity of major soils of Canada. All completed soil landscape maps are stored in digital form in the NSDB of CanSIS.

The basic products of CanSIS are maps and reports in computer-generated format (either digital or hard copy). Where possible, routine procedures are used to streamline the operations. However, custom products are created as required and within the constraints of resources. This section relates only to the release and distribution of data in digital form.

All digital soil maps that meet the minimum required level of data AND that have been published are available for release in digital form. There is a charge for materials used and there may be a charge for the service.

NOTE: DIGITAL DATA THAT DO NOT YET MEET THE MINIMUM LEVEL OF COMPLETENESS AND/OR THAT HAVE NOT BEEN PUBLISHED CAN BE RELEASED ONLY WITH PERMISSION OF THE AUTHOR.

A signed DATA RELEASE AGREEMENT (included with the data) must be returned and maintained on file for all digital data released to other individuals or agencies. Other than the terms outlined in this agreement, there are no additional conditions on the use of the data by an outside agency.

Normally, the author of the map will be advised of the release of the data in digital form.

Data are released on magnetic tape or floppy disk in a limited number of standard formats easily produced from the ARC/INFO format. The exact number and type changes with user requirements.

Soil landscapes of Canada data have been compiled at a map scale of 1:1 million; they are released in units of metres in Lambert Conformal Projection. The accuracy of all data released is documented in the project pedigree file as calculated by comparison of points on the coverage with standard reference points. Where the data cannot be projected to georeferenced coordinates with an accuracy equivalent to 0.5 mm on the manuscript (the definition of cartographic quality at LRRC), the data will remain in arbitrary table coordinates.

Definition of a complete digital soil map A complete digital soil map includes all six items in the following list. Within the list, the items shown as **mandatory** represent the absolute minimum level of data for release of map data in digital form:

- A complete project pedigree file (**mandatory**).
- Standard coverage for the soil theme (**mandatory**)
  (may include hydrographic theme for base data and annotation theme).
- For *Soil landscapes of Canada* maps (scale of 1:1 million) the coverage includes three (3) attribute files relating to the polygon. These are the polygon attribute table (PAT) as created by the ARC/INFO software, a DOMinant attribute file defining the properties of the dominant landscape component of each polygon and a SUBdominant attribute file describing the subdominant components as already described. Each of these files contain references to specific typical soils, which are further characterized in the soil names and soil layer files. The user is responsible for making any linkages required between the files.
- A subset of the soil names file (SNF) and soil layer file (SLF), which contains all combinations of SOIL-CODE + MODIFIER, is included as part of the complete digital soil map.
- All ARC/INFO coverages are in geographic units or documented to be not accurate on conversion (**mandatory**). All ARC/INFO coverages include arc attribute tables (ATT) files to allow feature codes to be identified.

- Files to indicate the tolerances used and files to specify the parameters of the projection and coordinates used (**mandatory**).

Elements of a complete digital soil map The following files make up the information associated with digital soil maps:

Project pedigree file The project pedigree file provides a record of its lineage or pedigree of the digital map and the data sources and checkpoints along the way to its completion. This file is produced for each map in the system.

Thematic boundary files and associated information The ARC/INFO software generates a range of files to define the soil polygons (an ARC/INFO coverage). We have adapted some files to our application. The ARC attribute files characterize the thematic boundaries. The ARC attributes define features such as hydrographic or administrative boundaries normally stored and managed by other agencies. The definitions used by LRRC are identical to those of other agencies, in this case Energy, Mines and Resources (EMR), and are identified by a subset of codes appropriate for our application.

In addition, the digital product is a model of a portion of the earth's surface. Consequently, information about the georeferencing system, projection, and so on becomes important. Furthermore, it is important to record the parameters of tolerance and accuracy used in the computer to produce the final digital record.

Attribute files and their relationships The other important part of the definition describes the attributes and the relationships between the various kinds of data that make up a complete digital soil map. In terms of line data, the relationships incorporate base map data and other coverages to add positional reference information to the soil thematic boundaries. Within the thematic coverage, the individual polygons define the soil and landscape areas that are to be represented on a soil map. The polygon attribute table (PAT), as created by the geographic information system (GIS), can be related to attribute files to define the properties of each polygon and to relate them to the repetitive components of the soil map (Fig. 12).

The LRRC has verified that attribute records are present for each polygon. Areas that have not been characterized by soil landscape attributes are identified as water, ice, or as urban classes of the attribute (03) "kind of rock outcrop or other material at the surface" recorded in the dominant landscape file where they have a percentage distribution of 100 (see attribute 04). Further, the LRRC has validated the data. For all polygons for which the dominant landscape occupies less than 80%, and which also have inclusions occupying up to 15%, a record is confirmed in the subdominant landscape file.

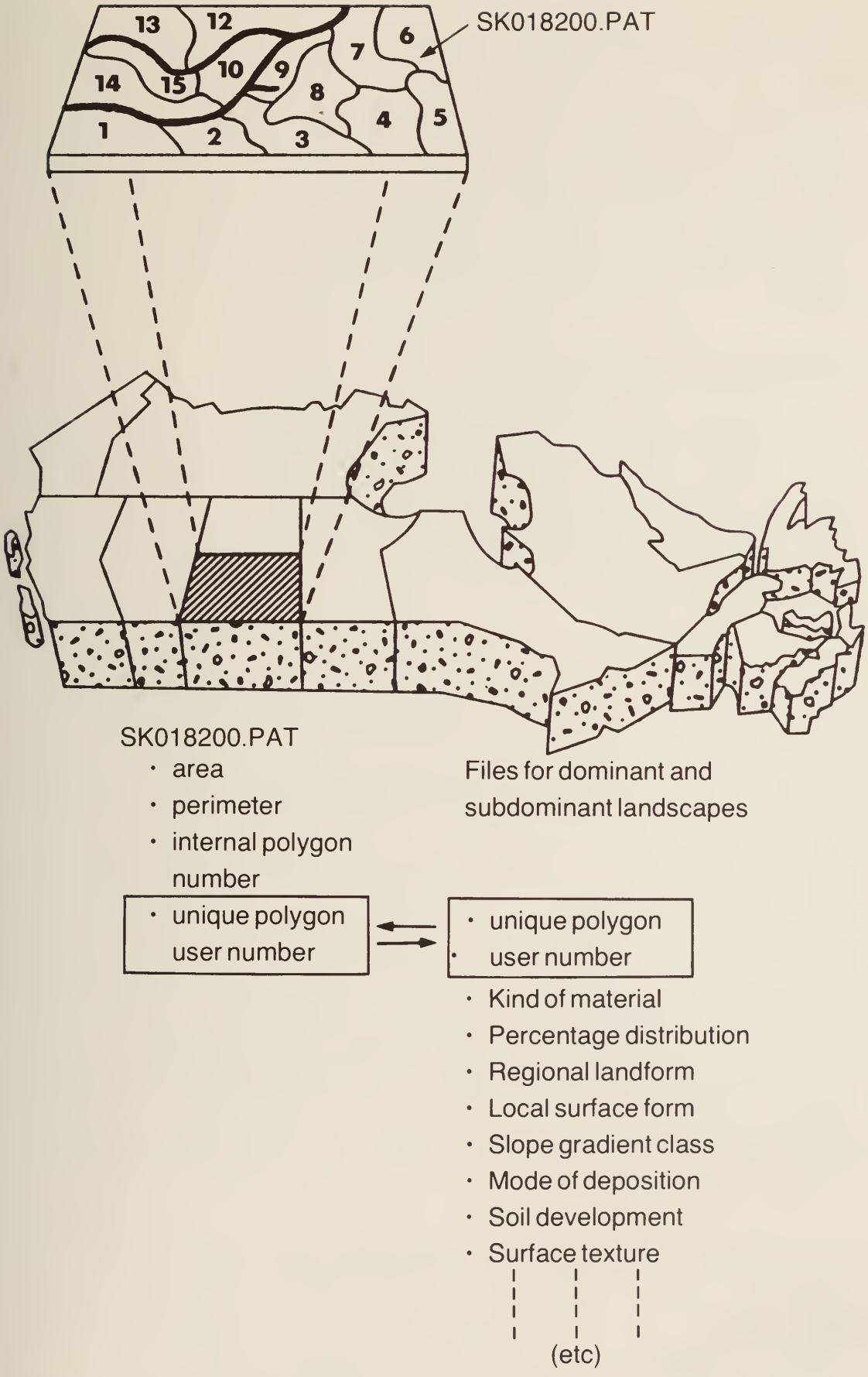


Fig. 12 Attribute files for soil landscape maps.

Soil names and soil layer files The soils associated with each soil landscape represent entities that can occur over a wide geographic region. They are characterized by general properties of the soil (e.g., drainage, water table, and mode of deposition) and also by properties of the layers or horizons. The soils identified in the landscape file represent typical soils in the landscape but do not necessarily represent the entire landscape component. The soil code and modifier from the landscape file points to the soil names and soil layer files for specific detailed information about the soil. These latter files are provincial in scope. The overall organization of the attribute data is within a relational data base model.

Products available

We are able to produce soil landscape information in various formats. The following products can be obtained on request from:

Land Resource Research Centre
Research Branch, Agriculture Canada
K.W. Neatby Building, Rm. B-71
Ottawa, Ont. K1A 0C6
Tel. (613) 995-5011
Fax (613) 995-7283

- printed, full-color map (*Soil landscapes of Canada*) and the short report containing the extended legend, packaged in a kit folder together with a sheet of illustrations and an information flyer
- full-color map only
- maps, legends, and lists of attributes for maps in preparation, available in manuscript form
- selected interpretive maps based on the attributes provided in the extended legend; interpretive maps completed or in preparation (others will follow) are

  Water erosion risk (for all provinces)

  Wind erosion risk (for Alberta, Saskatchewan, Manitoba, and southern Ontario)

  Soil salinity (for Alberta, Saskatchewan, and Manitoba)

  Acidification (for British Columbia, southern Ontario, and provinces east of Ontario)
- detailed computerized legends available on diskettes in ASCII format
- map data in digital form.

Procedures for release of digital soil map data

Consult the current list of *Soil landscapes of Canada* JOBIDs and map titles:

JOBID	*Map title*
BC01830N	Soil landscapes of Canada, British Columbia—North
BC01830S	Soil landscapes of Canada, British Columbia—South
AL088200	Soil landscapes of Canada, Alberta
SK018200	Soil landscapes of Canada, Saskatchewan
MN068200	Soil landscapes of Canada, Manitoba
ON017901	Soil landscapes of Canada, Ontario—South
ON017902	Soil landscapes of Canada, Ontario—North
QE018501	Soil landscapes of Canada, Quebec—Southwest
QE018502	Soil landscapes of Canada, Quebec—Southeast
QE018503	Soil landscapes of Canada, Quebec—Central
QE018504	Soil landscapes of Canada, Quebec—North
NB018300	Soil landscapes of Canada, New Brunswick
PE018500	Soil landscapes of Canada, Prince Edward Island
NS018501	Soil landscapes of Canada, Nova Scotia
NF018500	Soil landscapes of Canada, Newfoundland—South
NF018501	Soil landscapes of Canada, Newfoundland—North
YT018500	Soil landscapes of Canada, Yukon

Any person, agency, or organization interested in obtaining digital map data for the soil landscape maps should contact the following:

CanSIS Project Leader
Land Resource Research Centre
Research Branch, Agriculture Canada
Central Experimental Farm
K.W. Neatby Building
Ottawa, Ont. K1A 0C6

and provide the following information, preferable in writing:

- Provide contact name at user end
- Give contact address
- List Tel.
- List Fax
- Identify user's software and hardware (e.g., ARC/INFO running on a VAX system)
- Identify data request for:
  Soil landscapes of Canada coverages/data—JOBID, Map title
- Specify optimum export format for coverage data
- Specify requirement and export format for attribute data
- Choose transfer medium (disk, tape)
- Choose preferred method of delivery by courier, regular mail, or other
- State date required.

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